SCIENTIFIC AMERICAN

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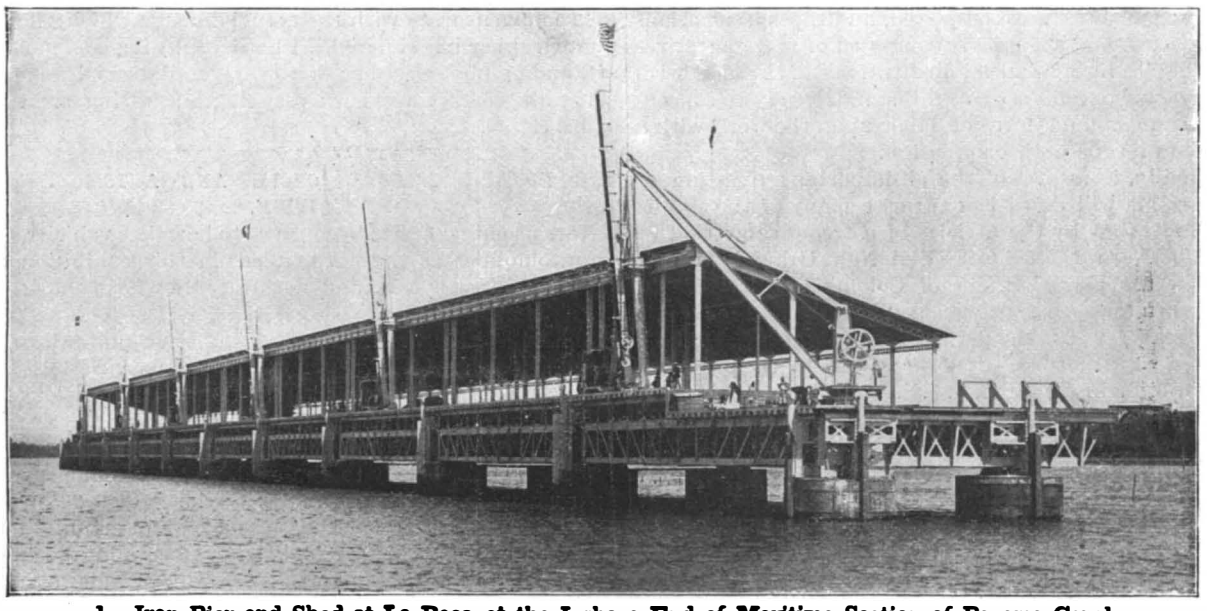
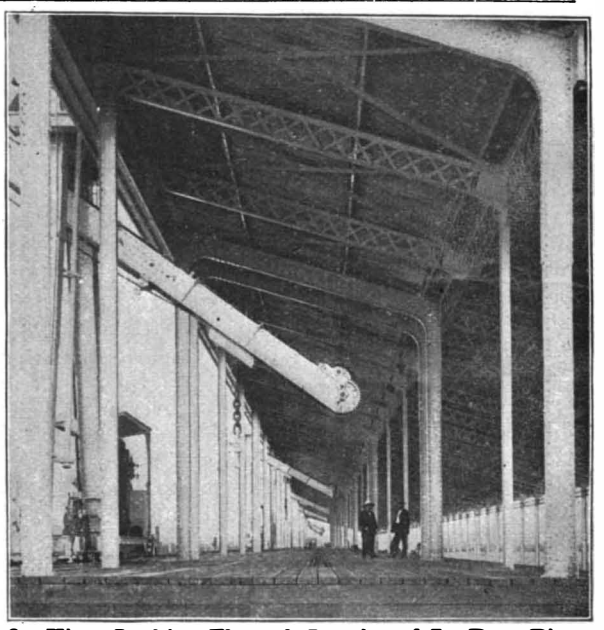
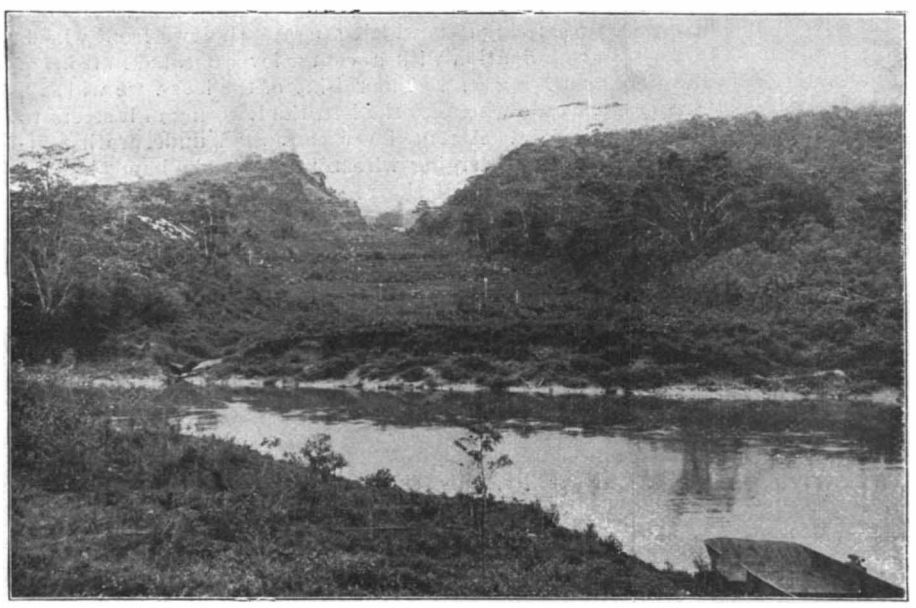


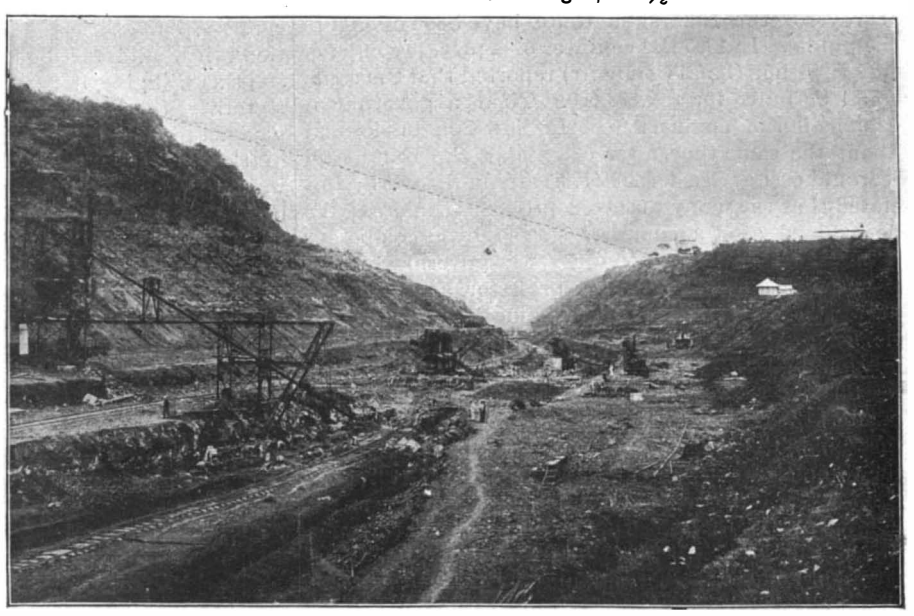
1.—Iron Pier and Shed at La Boca, at the Inshore End of Maritime Section of Panama Canal on the Pacific.



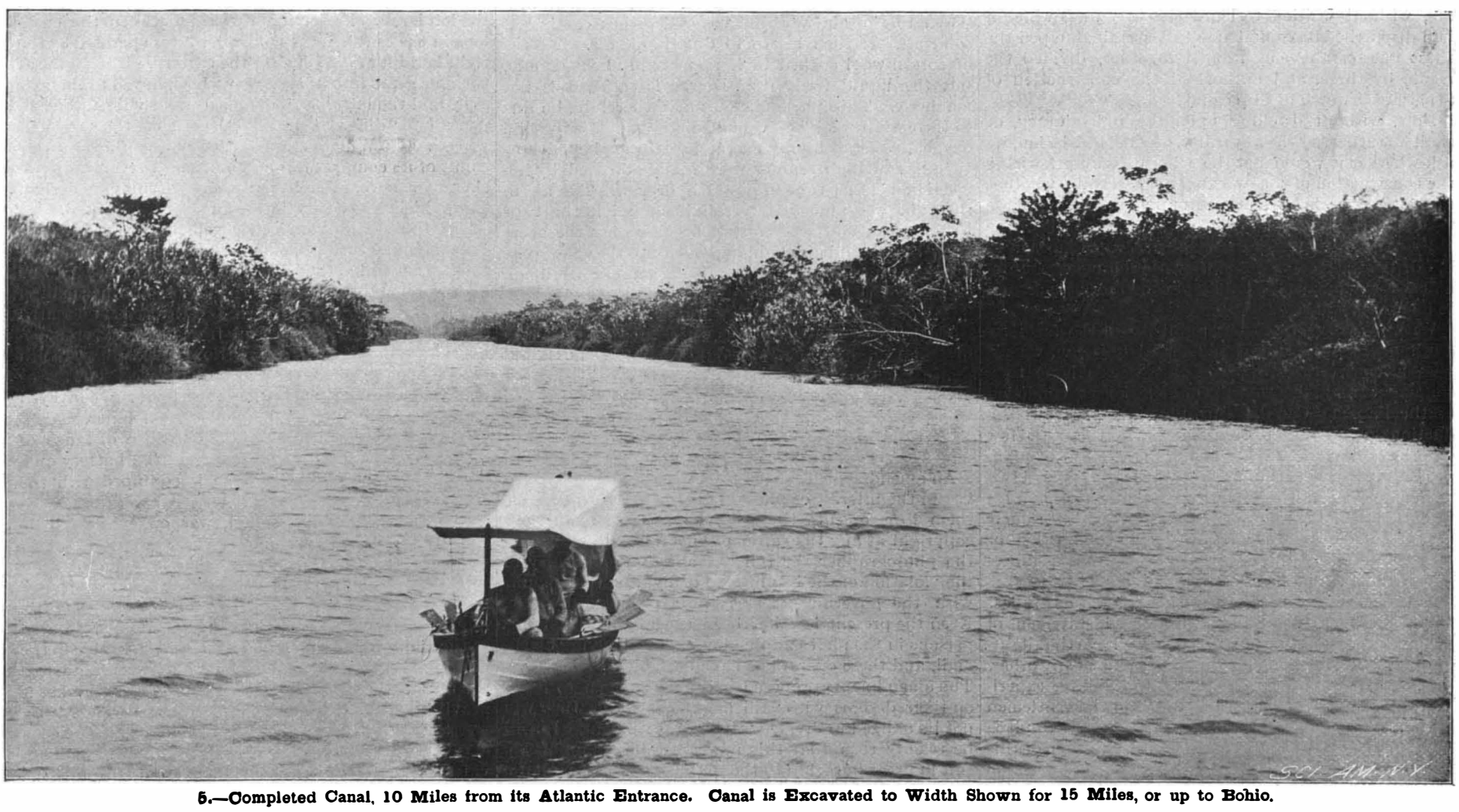
2.—View Looking Through Interior of La Boca Pier Shed. Length, 991½ Feet.



3.—Bohio—Site of Locks and Dam. Chagres River in the Foreground. Locks will be Built in the Rock Cut Beyond the River.



4.—Great Culebra Cut, 34 Miles from Atlantic. Dotted Line Shows Original Surface of Mountain.



5.—Completed Canal, 10 Miles from its Atlantic Entrance. Canal is Excavated to Width Shown for 15 Miles, or up to Bohio.

THE NEW PANAMA CANAL—PRESENT CONDITION OF THE WORK.—[See page 73.]

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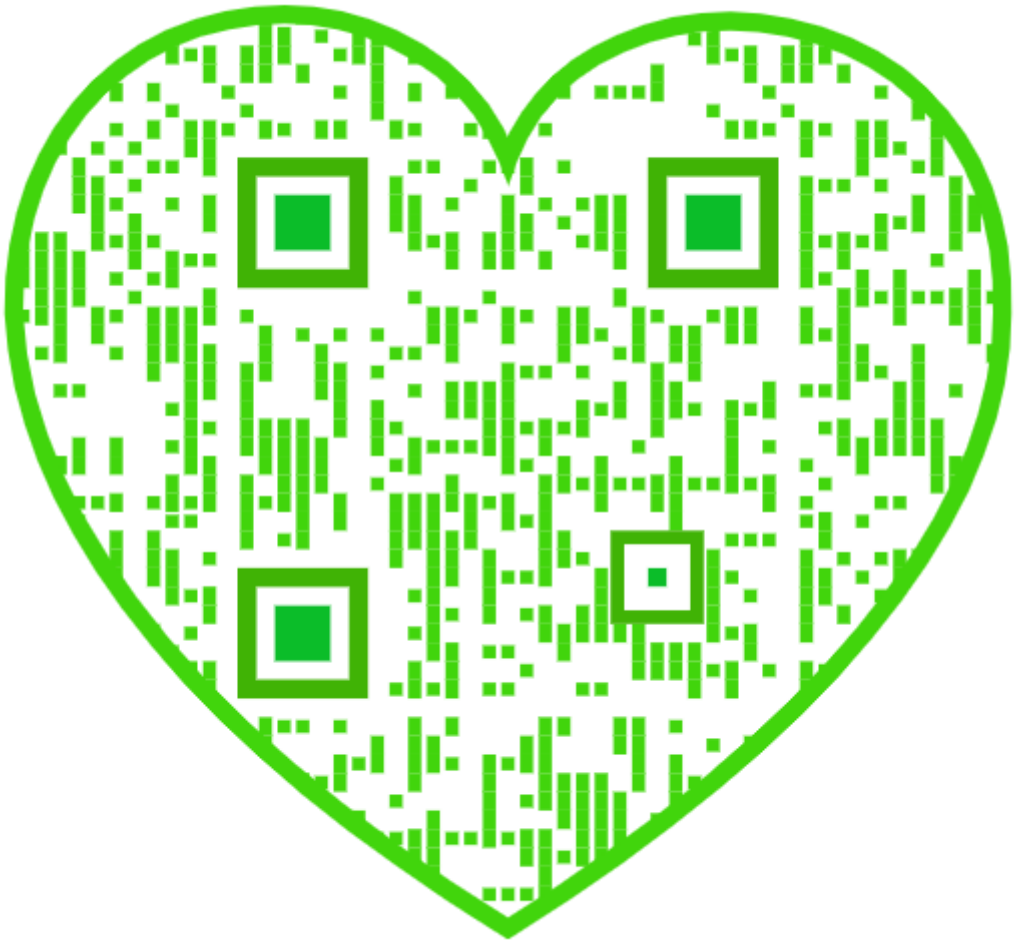

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NEW YORK, SATURDAY, FEBRUARY 4, 1899.

THE NEW PANAMA CANAL.

All the world is pretty well agreed that a ship canal ought to be built somewhere across the neck of land which unites North and South America. All the world is also agreed that only one canal should be built. The points upon which it is not agreed are as to where it should be built, by whom and at what cost.

The United States Senate has cut the Gordian knot at a stroke by declaring that it should be built at Nicaragua, by the United States government, and "for a cost not to exceed $115,000,000."

One of the most distinguished and representative bodies of engineers that ever gathered to discuss an engineering problem of international importance, after examining the results of a four years' survey by 150 engineers, has recently stated that the waterway should be cut through at Panama, where it finds a canal already two-fifths completed, and that the cost of its completion will be $102,000,000.

Three successive estimates, based upon preliminary surveys of the Nicaragua route, have been offered to the public. In 1895 the engineer of a private company (the Maritime Canal Company) reported that the canal could be built for $69,893,660. Then a government commission of engineers (the Ludlow Commission), at about the same time, after examining the route, said it would cost at least $133,472,893 to do the work; but stated that the many unsolved problems could only be determined after a complete survey by a competent staff of engineers. Thereupon the government dispatched an admiral, a college professor, and an engineer to make a more detailed examination. In its frantic haste to know the truth, and before the commission had had time to arrange its data and draw its final conclusions, the Senate demanded a statement of the cost. At a hearing before a committee of the Senate the college professor stated that he thought the thing could be done for "inside of $90 000,000;" the gallant admiral, "speaking as anybody on the street might speak, thought that the canal could be put through for $125,000,000;" while the engineer thought it could be built "for a maximum of about $140.000,000." The preliminary report of the Walker Commission, recently handed to the President, states that the cost will be between $123,000.000 and $140,000,000. The Senate, without waiting to learn the very facts which it had dispatched its commission to ascertain, lumped the three guesses above mentioned together, divided the result by three, and authorized the construction of $115,000,000 worth of ship canal!

Now, without dwelling upon the precipitancy, or shall we rather say the absurdity, of such legislation, we ask whether it would not be wise, before authorizing the construction of a new canal, to ascertain whether there is any probable competitor in the field. For we take it that if it were once proved to the people of the United States that another canal was within measurable distance of completion, they would never countenance for a moment the folly of constructing a second in its close proximity.

With a view to giving publicity to the facts regarding this vital and fundamental question, we devote a considerable part of this week's issue to a statement and illustration of the exact condition of the Panama Canal. Our illustrations are reproductions of photographs taken within the past few months along the route of the canal. The plan, profile, and cross sections are drawn from plans furnished by one of the American members of the International Commission of Engineers, and the facts are taken from the recent report of the commission, or were communicated to us verbally by various members of the commission, American and foreign.

In presenting the data we wish to give it our fullest indorsement as being an exact, unbiased statement of facts; and we do this, not because we have the slightest interest in the Panama scheme as against any other, but because we are satisfied that the ability, experience, and high professional character of the gentlemen of the International Commission are such as to place their findings upon any engineering question of this kind beyond the faintest suspicion of incompetence or partiality.

If expert testimony counts for anything, the unanimous report of a commission which includes the chief engineer of the Croton Dam and the chief engineers of the Manchester and of the Kiel canals, in favor of the construction of the Panama scheme, should set at rest all doubts of the feasibility of the plans as now drawn up, and lay forever the ghosts of floods, fraud and fevers, which have haunted this enterprise ever since the days of De Lesseps' catastrophe.

The Panama Canal then is feasible, and the cost and time of its construction are accurately known. Two-fifths of the actual excavation is completed, a plant that cost originally $30,000,000 is scattered along the route, engineering surveys of the most thorough character are completed, the working plans for every structure big or little are completed, and the specifications drawn up; and a company composed of representatives of the leading financial institutions of France with $13,000,000 of paid-up capital stands ready to concentrate a maximum force of labor upon the work with a view to its energetic completion.

Finally, in respect of the all-important question of control, it will doubtless surprise many of the public to know that by the articles of a treaty concluded in 1848 between this country and New Granada (which is now the United States of Colombia) this country, in return for special privileges, "guarantees" (to quote the treaty) ". . . the perfect neutrality of the isthmus with a view that free transit from one to the other sea may not be interrupted, . . . and the United States also guarantee, in the same manner, the rights of sovereignty and property which New Granada has and possesses over the said territory."

These rights are of the very essence of sovereignty, and, in accordance with their stipulations, this country has already had occasion to land its forces to protect the property of the Panama Railroad.

After consideration of the facts as above set forth, the question will naturally suggest itself whether, if it is desirable for the government to participate in the construction of a canal (which we very much question), it would not be advisable for it to take such steps as will give it a strong representation in the directorate of a company whose property it is by treaty pledged to protect. Should the question be answered in the affirmative, the next and most obvious move would be the appointment of an expert commission to be given all the time it needs to look carefully into both the Nicaragua and Panama schemes, and report which, all things considered, has the most features to commend it to the support of the United States.

In a future article we shall present the available data regarding the Nicaragua scheme. Our first attention has been given to Panama because we believe that any discussion that ignores or belittles the older enterprise is worse than misleading.

PROF. DEWAR'S EXPERIMENT WITH LIQUID HYDROGEN.

It is now about eight months since hydrogen has been liquefied in the laboratory, and on January 20 Prof. Dewar gave an interesting lecture on the subject at the Royal Institute. His experiments were most interesting, and a description of them has been cabled to The New York Sun. A little ball, cooled and exposed to the air, was first covered with a coating of solid air. It then began to drop liquid air. A piece of cotton wool soaked in it appeared to be magnetic, but the liquid itself Prof. Dewar is satisfied is not magnetic. This phenomenon must, therefore, be due to the cotton wool being immediately filled with solid oxygen, which is highly magnetic. He explained how vacuums of high tenuity were easily obtained by immersing a closed tube in liquid hydrogen. The air in the tube was immediately solidified, and if the tube was so arranged that the portion combining the accumulation of solid air could be sealed up, the other part would have, according to the calculations of Sir William Crookes, a pressure amounting to only one ten-millionth of an atmosphere. With vacuum vessels for use with liquefied hydrogen it is, therefore, not necessary to pump out the air. It is only needful to put liquid hydrogen in a double walled vessel and it may itself make a vacuum by solidifying the air between the two walls.

COPYRIGHT OF PHOTOGRAPHS.

An amendment has been proposed to the copyright law in the interest of photographers, which will enable them to prosecute the alleged infringement of their copyright at any time after publication. It also gives the photographer the full amount of the penalty of the violation of the law instead of dividing the amount with the government, as is now provided by law. Even the present law has been used by unscrupulous persons in the photographic business for levying blackmail, and these operations have been highly successful. The amendments proposed will enable them to carry on their designs with still more success, as they will not be obliged to divide with the government. It will be readily seen that this new amendment might result in great hardship to the publisher; thus a photograph might be brought to the newspaper, which had been remounted, cutting out the copyright notice, or it may not have been copyrighted at the time of publication. The owner of the copyright sees the violation, and after waiting two or three years sues the newspaper publisher, the photographer saying that the newspaper published a copy of his copyrighted picture. This may or may not be the case, but in the meantime it is more than likely that the newspaper editor will have lost all trace of the photograph from which the cut was made and he is practically without means of proper defense. In many cases innocent infringers have had to pay $5,000 for using a photograph the value of which was not $5. The law should be amended so as to bring damages within reason, and endeavor should be made to make them in some degree commensurate with the actual damage which the photographer has suffered. Photography is a common art, and no photographer was ever yet damaged anything like $5,000 for even a very flagrant infringement of his rights.

THE FOURTH ANNUAL CYCLE AND AUTOMOBILE EXHIBITION.

More prominence has been given to horseless vehicles, or automobiles as they are called, in this exhibition than in previous years, and naturally they form one of the chief attractions to visitors.

The exhibition was held in the Madison Square Garden, in this city, from January 21 to January 28, 1899, the main floor being divided in sections for the various exhibits of many different manufacturers of bicycles and accessories.

We shall refer briefly to the exhibits of automobiles. Near the main entrance slightly to the left stood an electric runabout styled the "Orient," and manufactured in Waltham, Mass. Its bright red running gear contrasted well with the black body. The framework for holding the body and motor is built of weldless steel tubing, and the front axle support is swiveled to allow for unevenness of roads, there being attached also steering rods which operate the two front wheels in combination with a center lever located in front of the driving seat. The raising of the lever, we will say, turns the wheels to the left, the lowering of it steers to the right. A foot lever connected underneath rearward, by diverging wire ropes to brake bands located near the hubs of the rear wheels, operates the brake. A three-kilowatt motor attached to the frame underneath gears into a special spur differential gear, thereby equally distributing the power on the wheels whether going straight or around a curve. The controller lever for switching on the electric current is on the outside of the carriage, left side. The chloride accumulator battery is located in the rear compartment and has an efficiency of 1,800 ampere hours or a discharge which will propel the vehicle for twenty-five miles on a level road.

Near by this exhibit, on the left, were three electric vehicles by the Riker Electric Company, one of which was a new covered phaeton, light in construction and tasteful in design. In this vehicle a special steering gear is provided working the hubs of the front wheels, and connected to a vertical steering rod which rises to the level of the seat and is there hinged to lie horizontally, with a handle on the end for steering with the left hand. Projecting upward between the cushions in the center is the controller lever operated by the right hand for switching on the battery. The motor at the rear gears into a large gear wheel, keyed to the rear axle, and the latter is ingeniously constructed to compensate for different rates of speed of the two rear wheels. The Willard storage battery is employed on account of its compactness and efficiency. Another vehicle was a covered delivery wagon of unique design. The vehicle is very attractive and easily operated.

The third exhibit of electric vehicles was that of the Pope Manufacturing Company, of Hartford, Conn., at the further end of the hall. These vehicles appear to be more solid and substantial than those of other makes. Three styles were shown, a top-covered two-seated doctor's vehicle, a four-seated trap, and a covered delivery wagon of solid proportions, all equipped with the usual controller lever and brake device. The motor is well incased at the rear, motion being conveyed therefrom to the wheels in an effective manner.

It was said these vehicles would make a distance of thirty-five miles on one charging of the battery on a hard level road. Each carriage is equipped with the chloride storage battery.

Near by, in the same section, was on exhibition by this company a novel motor merchandise vehicle, propelled by a gasoline motor. The carrying boxes are supported on each side of the main central frame, there being one steering wheel in front and two driving wheels at the rear. The gasoline motor is located at the right hand side, about ten inches above the ground, and gears into a driving shaft running across the rear of the machine. The motor cylinder jacket is provided with flanges for cooling by air currents.

Attached to the main shaft is a chain connected with a separate foot-driven sprocket wheel. A seat is provided conveniently for the operator, who, to start the machine, works the foot pedals. The forward motion

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of the vehicle pumps the gasoline and air mixture into the motor. The electric igniter then explodes the mixture in the cylinder and the machine travels by its own power, the operator at the same time, by means of a lever, disconnects the foot crank and steers the forward wheel by the usual cycle handle bar. It travels at ten miles an hour and under, and is said to be an excellent hill climber.

Another new gasoline-propelled vehicle, on the south side of the room, was the Tinkham tricycle, for one person. It is provided with a small, double cycle motor, having the usual mixing chamber. The water for cooling the cylinder is in a tank the width of the machine located over the motor between the two rear wheels, forming a cover for it. A hand lever on the left throws in or out a clutch which connects the driving shaft to a pedal crank conveniently operated by the feet like a bicycle. To start the machine, the driving shaft, when clutched to the pedal crank clutch, is rotated by the movement of the feet, the clutch is then disconnected by the hand lever and the feet raised and supported on two rests. The speed is regulated by pressure on a small lever attached to the steering handle bar, which cuts off the supply of air to the mixture. The electric sparking is produced by a small storage battery which is kept charged by a small dynamo geared to the shaft. A muffler is provided at the rear to soften the sound of the exhaust. It has a speed of 15 miles an hour.

A third and most attractive looking gasoline motor carriage designed to carry two persons was called the "Hertel," made in Greenfield, Mass. The striking feature was its lightness and compactness and method of applying the power to the wheels. Beneath the seat is carried the supply of gasoline, water tank, and storage sparking battery, kept charged by a small dynamo geared to the main driving shaft. There are two cylinders placed horizontally, which operate the main shaft. One lever in the center near the seat brings to bear a countershaft in contact with the main shaft, and the driving pulleys on each end of the countershaft on the outside impinge by friction on special concentric rails secured to the inside of the rear wheels. Pushing the lever forward brings the pulleys in contact with the wheels and sets the vehicle in motion; drawing the lever backward puts on the brake and at the same time removes the driving gear from the wheels. The engine is also started by a back and forth movement of the same lever. By another lever the two front wheels are steered. The weight of the vehicle is 500 pounds. Its manipulation is said to be so simple that a lady can operate it without difficulty.

The wheels of all these vehicles are fitted with heavy pneumatic tires of large dimensions.

In the line of cycles, perhaps the most prominent improvement is the introduction of various chainless gears. The Pope Manufacturing Company have perfected their bevel gear driving mechanism during the past year in such a way as to make a smoother running wheel and prevent undue friction.

The Grand Rapids Cycle Company exhibit also a plain bevel gear bicycle called the "Clipper," well built and light weight.

In the Sager gear is shown a combination of a peculiar shaped bevel spur with a roller gear on the axle of the driving wheel, designed to reduce the usual friction of a bevel gear.

Still another form is the Bullis gear, in which miniature rollers on projecting spurs take the place of the usual spurs of a bevel gear and mesh into each other at an angle like a bevel gear.

A novelty in the chainless line was tandem chainless bicycles, located at the east end of the hall.

The usual sprocket pedal wheel had gear teeth on its periphery which geared into a run-around ring of large diameter, traveling on ball-bearings over a stationary ring supported on the frame of the bicycle, and geared on the opposite side into a second toothed pedal wheel. This in turn geared on a second large run-around ring and that into a gear wheel on the end of the axle of the rear wheel. The power is thus transmitted through the medium of these gears and run-arounds directly to the rear wheel.

In the line of accessories and minor improvements there were on exhibition four or five different styles of acetylene lamps, unique devices for quickly adjusting the height of the seat on the seat post, notably that of the "Tribune" bicycle, novel contrivances for ringing a bell from bicycle wheel, and a curious adjustment of the bicycle pedals which could be immediately detached from the sprocket wheel by a slight back pressure, desirable in coasting. Numerous exhibits of adjustable handle bars were to be seen. On the "Cleveland" bicycle we noticed a new simple bi-speed gear arrangement operated by a rod running up to the seat, which permitted the rider, when in motion, to quickly change the gear from low to high speed or vice versa. There seemed to be a desire on the part of manufacturers to supply the public with the chain or chainless machines as it might select. In the Orient cycle exhibit we noticed a six-seated racing bicycle which had a main sprocket wheel twelve inches in diameter.

In another issue we shall give illustrations of some of the novelties in the exhibition. As a whole it was particularly interesting, especially in the progress shown in automobiles.

THE VERDICT IN THE TANK COLLAPSE CASE.

Coroner Zucca and a jury concluded, on January 24, an inquest in the case of the eight men who were killed by the collapse on December 13 of the large tank of the Consolidated Cas Company at First Avenue and 23d Street, which we have already illustrated. After taking expert testimony the jury returned a verdict that the deceased came to their deaths by asphyxia and by drowning, and that the construction and materials of the tank were in accordance with the plans and specifications, and that the workmanship was of good character. The jury recommended that in view of the fact that neither the design nor the construction of such gas-holder tanks is under the supervision of any city department, all such work in future should be subjected to proper municipal supervision and control.

THE HEAVENS IN FEBRUARY.

BY GARRETT P. SERVISS.

In this month the great winter constellations which center about Orion gradually shift their places to the western half of the sky, while less brilliant star companies, led by Leo and Virgo, occupy the east. At 10 o'clock P. M., in the middle of February, the Milky Way arches the sky in a nearly north and south line. The Great Dipper is high in the northeast and Cassiopeia low in the northwest.

Early in the evening Orion is on the meridian, and advantage should be taken of his favorable position for study of the beautiful star Betelgeuse, in the imaginary giant's right shoulder. This star is remarkable both for its color, a rich topaz, and for its irregular variability. Ordinarily Betelgeuse is about twice as bright as Aldebaran, the leading star of Taurus, but, according to an estimate recently made at the Cape of Good Hope Observatory, it is, this winter, but slightly superior to Aldebaran. It may lose yet more of its light, and attentive observation may result in the discovery of some law governing its variability. That a sun of such presumably enormous magnitude as Betelgeuse possesses should lose, for a time, one-half its radiant power is a phenomenon calculated to arrest attention and excite wonder. Together with observations on its brightness as compared with Adelbaran and with its white neighbor Rigel in Orion's foot, the color of Betelgeuse should also be carefully watched. There is here an opportunity for amateur astronomers possessed of normal color vision to add something of value to the stock of astronomical knowledge. The colored stars present a fascinating but difficult problem, and a careful record of their hues, arranged on a simple chromatic scale, would be highly interesting and might prove highly important.

A hint of what can be done is conveyed by the fact that Betelgeuse and Aldebaran, although both are sometimes called red stars, have by no means the same color tone, while Antares, another red star, presents a still different tint.

THE PLANETS.

Mercury is a morning star, moving in the course of the month from Sagittarius across Capricornus into Aquarius. But it is too near the sun for observation.

Venus is also a morning star, and conspicuous for two or three hours before sunrise. She reaches her greatest western elongation on February 10. She is in the constellation Sagittarius.

Mars remains the most striking stellar object in the evening sky. He crosses the meridian about 10 o'clock in the middle of the month. He is in the constellation Gemini, south of the twin stars Castor and Pollux, and greatly outdoes them in brightness. His brilliancy diminishes, however, all through February, as the distance between him and the earth is widening at the rate of several hundred thousand miles in a day.

Jupiter, in Libra, is an evening star, rising before midnight, and in the course of a few weeks will take the place of Mars as the planetary cynosure. Recent studies of his cloud belts indicate that the giant planet continues to be the scene of stupendous surface changes, which probably affect only the vapors that envelop his globe, but which give rise to a wonderful and beautiful spectacle in the telescope.

Saturn is a morning star, rising several hours before daybreak, in the constellation Ophiuchus, near the place where the new star of 1604 appeared. Recent observations of Saturn by Monsieur Antoniadi show that the ball of the planet does not lie exactly in the center of the rings, but appears shifted slightly toward the west. The explanation of this singular appearance is obscure. Antoniadi's drawings of the planet, made within a few months past, also show very plainly the series of light and dark belts parallel with the equator, and the tendency of the outer ring, near the extremities of the larger axis, to break up into cloud-like masses. This appearance may arise from tidal waves, or waves of condensation and rarefaction running through the masses of minute satellites that compose the ring.

Uranus is a morning star in Ophiuchus, five degrees almost directly north of Antares.

Neptune is an evening star in Taurus.

THE MOON.

February opens with a waning moon, the satellite reaching last quarter on the 3d. New moon occurs on the 10th, first quarter on the 17th and full moon on the 25th.

There will be a minimum of the variable star Algol ten minutes before 9 o'clock on the night of February 8. There are no conspicuous meteor showers in February.

PHILIPPINE ARCHITECTURE.

According to Prof. Dean C. Worcester, the houses rest on four or more heavy timbers which are firmly set in the ground. The floor is raised some five or ten feet from the ground. The frame is of bamboo tied together with rattan and nails are not used. The sides and roof are usually of palm, and the former may be made by splitting green bamboo, binding the halves flat and then sewing them together. If palms are scarce, the roof may be thatched with long grass. The floor is usually made of bamboo strips with the convex side up. They are tied firmly in place in such a way that wide cracks are left between them. The houses are entered by ladders; in some cases there is only one room, and the cooking is done over an open fire built on a heap of earth in one corner, and as the opening for the exit of the smoke is inadequate, the room is sometimes rendered almost uninhabitable. In the better classes of dwellings the house is divided into several rooms, and there is a place partitioned off for cooking. There are windows which are provided with swinging shades. Prof. Worcester states that native dwellings which are properly arranged have much to recommend them. The ventilation is perfect and the air is kept much cooler than in a tightly closed building. The construction is so light that if they are thrown down by an earthquake or blown down by a typhoon no one is injured, as the material is too light to do any damage. The richer natives sometimes build houses of boards with galvanized iron roofs and limestone foundations, but they are very much more expensive and are pronounced decidedly less comfortable than the more humble dwellings which we have described.

WINE STORED UNDERGROUND.

An experiment in handling red wine was tried last year at the Italian-Swiss colony's vineyard, situated at Asti, in the State of California. The grapes handled by the colony were far in excess of the cooperage facilities it possessed, and some means had to be devised to care for the surplus. Among the different plans suggested was that of building a concrete cistern, and this idea was finally adopted. An excavation was first made in a rocky hillside in the rear of the establishment. Next walls of concrete 2 feet in thickness were put in, and the floor and top were added to in an equally substantial manner, the latter being supported by fifteen steel girders. Then the entire surface was covered with a lining of pure cement, and finally this was glazed to the impermeability of glass. The whole cistern was buried beneath 3 feet of earth, the object of all these precautions being to preserve the wine at a uniform temperature. This cement tank is 104 feet long, 34 feet wide, and 24 feet high, and is capable of holding 500,000 gallons. The wine was kept in this reservoir for four months or more, and the experiment is said to have been entirely successful. It was then drawn off by gravitation into wooden tanks, in which it will be allowed to mature previous to being placed in barrels for shipment. There are said to be several advantages derived from treating the wine in this manner. One is that it can be maintained at a cool, even temperature; another is the equal blending of such a large quantity of wine at one time, and a third is the great saving in insurance, which is expected to repay the cost of the construction of the tank in five years.

OUR IMPORT TRADE FOR 1898.

The import record of the calendar year 1898 is as remarkable as that relating to its exports, but for opposite reasons. The total imports of the year are less than those of any calendar year in more than a decade, while the exports of the year are the largest on record. The imports fall more than $100,000,000 below those of 1897 and nearly $50,000,000 below those of the years of great depression, 1896 and 1894, on which occasions the imports were phenomenally light. That the importations in the early part of the year 1898 should have been light was not surprising, because of the heavy imports in certain lines prior to the enactment of the tariff law of 1897; but that they should continue light during the entire year in the face of the large home demand, which prosperous business conditions would naturally create, has proved surprising to those following closely the commercial developments of the year. The importation of a full year's supply of wool, sugar, and other articles of that class just prior to the enactment of the Dingley law naturally had a marked effect in reducing the imports in the closing months of the calendar year 1897; but that the imports of the closing months of 1898 should remain as low as those of 1897 is a matter of very considerable surprise.

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A WATER-FEEDING DEVICE FOR GRINDING-WHEELS.

There has recently been patented by George J. Ridley, of Auburn, N. Y., a novel method of feeding water to grinding-wheels, whereby many objections hitherto encountered are overcome.

The grinding-wheel itself is mounted in the usual

RIDLEY'S GRINDING-WHEEL.

manner. Below the grinding-wheel, but not in contact therewith, a water-feeding disk is mounted and partially submerged in a reservoir containing water. The disk and grinding-wheel are driven by a belt running over pulleys on the wheel and disk shafts.

The emery-wheel is covered by a hood, so that no water can be scattered about while the wheel is in operation. The hood extends down and covers the feed disk. A slide is mounted in guides so that it may be inserted between the emery-wheel and the feed-disk.

When the grinding-wheel is rotated, the feed-disk is also rotated, and the water which is lifted from the reservoir will be thrown by centrifugal force against the grinding-wheel. The amount of water thus supplied to the wheel may be regulated by moving the slide in or out.

In this device the feed-wheel is not in contact with the grinding-wheel, but is rotated thereby, with the result that the grinding-wheel is wet only when in use and that the connection between the wheel and disk is not disturbed by uneven wear.

A NEW WAY OF CONSTRUCTING DRAWBRIDGES.

In drawbridges of the swinging and revolving type, as at present constructed, considerable time is lost by the slowness of operation of the draws. In order to overcome this objection, William L. Sampson, of Ocean Grove, N. J., has constructed a drawbridge which consists primarily of movable cantilever spans having inclines, and aprons adapted to be engaged by the inclines and swung into an angular position.

Of the accompanying illustrations, Fig. 1 is a side elevation of the bridge, showing the draw closed; Fig. 2 is a similar view, showing the draw open; Fig. 3 is an enlarged section of the adjacent ends of the spans locked together; and Fig. 4 is an enlarged transverse section of the base of the span locked to the abutment.

The cantilever spans of the bridge are constructed to travel toward and from each other on foundations extending above the water-level. In order to impart this movement to the spans, a rope or chain, passing through a tunnel or conduit in the bed of the river, is connected with the ends of the spans and with a drum on shore driven by suitable machinery.

When the spans are in closed position, their two inner ends abut against each other, and the outer or shore ends abut on the aprons; and since the aprons are in turn hinged to the abutments, a continuous bridge is formed from shore to shore. The aprons at their under sides are provided with wheels normally resting on tracks and adapted to travel up the inclines of the spans. An engineer stationed in a power-house on shore can readily move the spans from the abutments to close the waterway or toward the abutments to open the waterway, in which latter position the aprons will be raised.

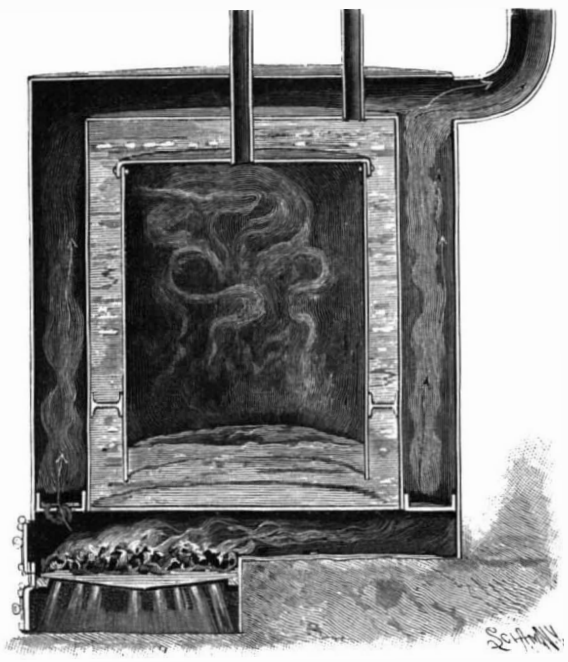
In order to lock the spans securely in place when the waterway is closed, and to prevent all lateral movement, the outer trusses are provided with heels extending upon the floors of the opposite spans as shown in Fig. 3. Locking bolts engage the heels and the floors of the spans, and a second set of bolts connected with the first-named bolts engage registering recesses in the timber of adjacent trusses. The bolts are controlled by the engineer through the medium of ropes.

The inner ends of the spans are also adapted to be locked in place when the bridge is closed, and for this purpose, the device shown in Fig. 4 has been devised. The arrangement consists of movable bars on the base of each span, each bar being provided with pintles. Fixed eyes on the side walls of the abutments are adapted to be engaged by the pintles. By means of a rope and operating lever the engineer can simultaneously move the bars in order to shift the pintles in and out of locking engagement with the eyes.

The special advantages of this bridge are the simplicity of its construction and the time saved in opening and closing the draws. Not only is the invention applicable to bridges, but to viaducts and crossings as well.

AN IMPROVED STEAM-BOILER.

In the accompanying illustration we present a novel steam-boiler in which an inner and outer shell are provided, the inner shell being open at the bottom and designed to collect the steam, and the space between the inner and outer shells being filled with water. When heat is applied to the outer cylinder, the bottomless inner shell will be filled with steam: the air will be exhausted; the space between the cylinders will be filled with water; and the exterior surface of the outer shell will be enveloped by flame or heat. The steam generated within the interior cylinder maintains by its pressure a thin layer of water on the bottom, the

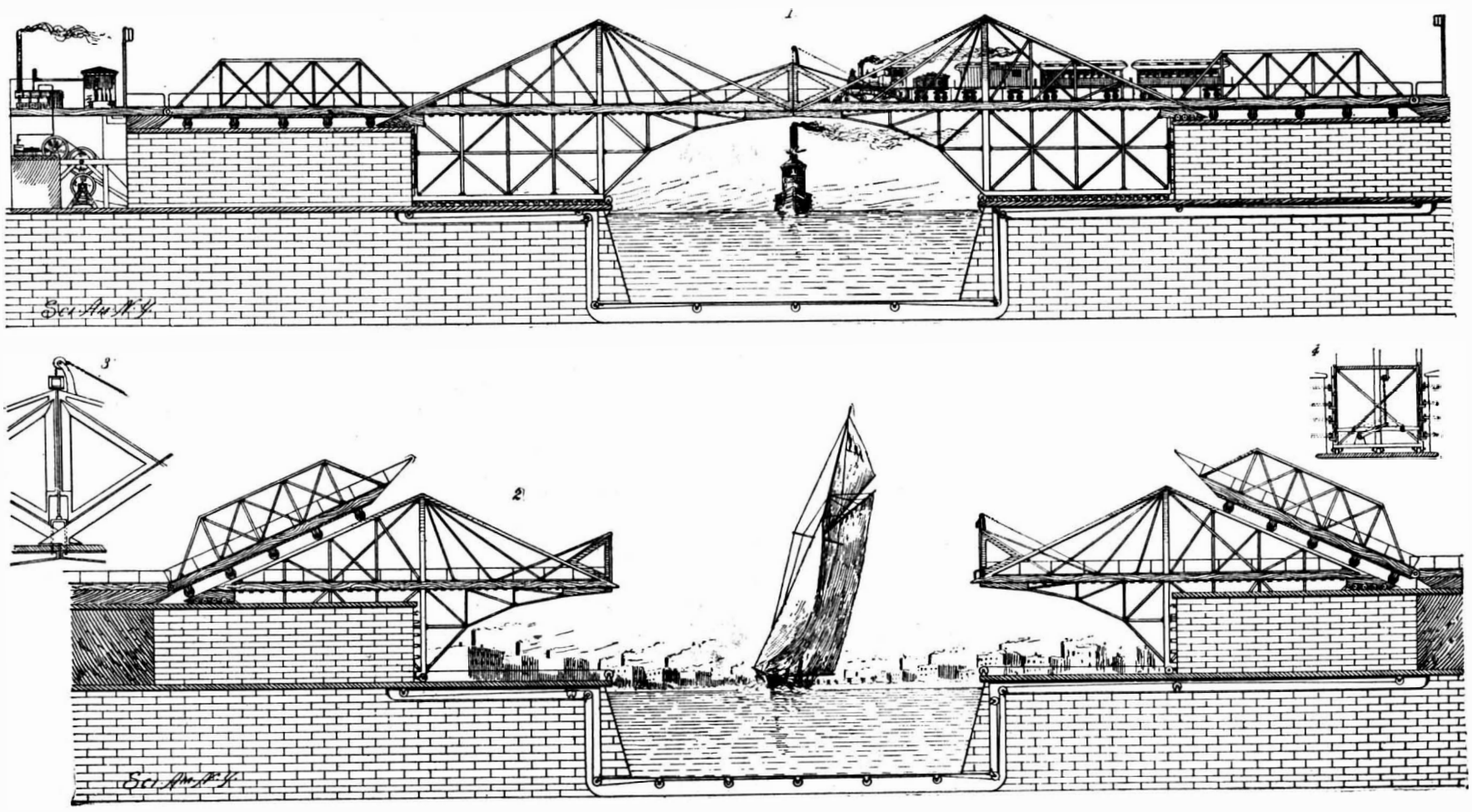


STAUBER'S STEAM-BOILER.

interior cylinder acting somewhat like an inverted bell-jar. When the fire decreases in intensity, the interior cylinder becomes partly filled with water; when the heat is at its maximum temperature, the water is forced out of the interior cylinder. The inventor of this boiler, Benjamin T. Stauber, of Jewell City, Kan., claims for his invention cheapness of construction, a saving of fuel, and ability to raise steam rapidly and to make large reductions of steam without blowing off. By the addition of an air supply pipe, air can be heated in the interior shell, and supplied in the usual manner.

A New Power Scheme for Niagara.

New York and Buffalo men have organized a company for the purpose of developing the great power of the whirlpool rapids by means of a canal which shall be built inside or beneath the tracks of the gorge road. This canal will be 530 feet long and 100 feet wide. It will be capable of furnishing 35,000 horse power at the whirlpool under 45 feet head. It is thought that the cost will be about $2,000,000.



SIDE ELEVATIONS OF SAMPSON'S BRIDGE, SHOWING THE DRAW CLOSED AND OPEN.

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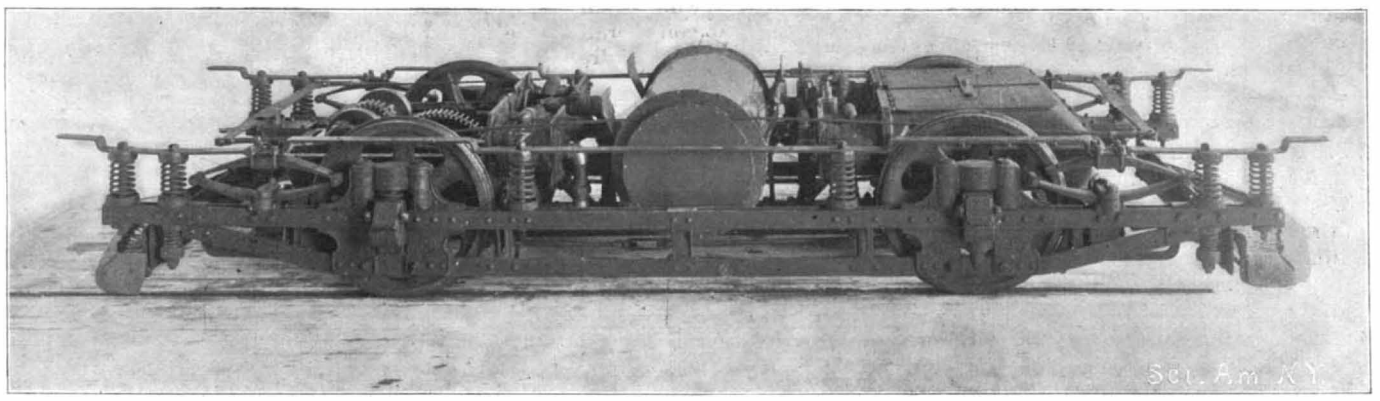
THE HOADLEY-KNIGHT COMPRESSED AIR MOTOR.

In our last issue we gave some account of the development of compressed air traction on the streets of New York city, and drew attention to the fact that experimental and practical work in this direction had been done with two motors, one known as the Hardie motor having been run on several cars on the One Hundred and Twenty-fifth Street line of the Third Avenue Street Railway Company, and the other, built under the Hoadley-Knight patents, having shown good results in operating several cars on the Lenox Avenue branch of the Metropolitan Street Railway Company's system. In the Hardie motor compressed air is used in a single, two-cylinder, high-pressure engine. It is carried in steel reservoirs, located under the seats of the car, and on its way from the reservoir to the motor the air is heated by passing it through a tank of hot water, stored under a pressure of several hundred pounds to the square inch.



COMPOUND, COMPRESSED AIR MOTOR TRUCK, AS USED ON STREET RAILWAYS.

The Hoadley-Knight motor differs from the Hardie type chiefly in the methods of heating the air and in the fact that the motor is on the compound system. The superior results obtained with the Hoadley type have led to a combination of two companies into the new American Air Power Company, which controls all the patents of both systems, and is now actively engaged in building and supplying the Hoadley-Knight motors for all classes of work.

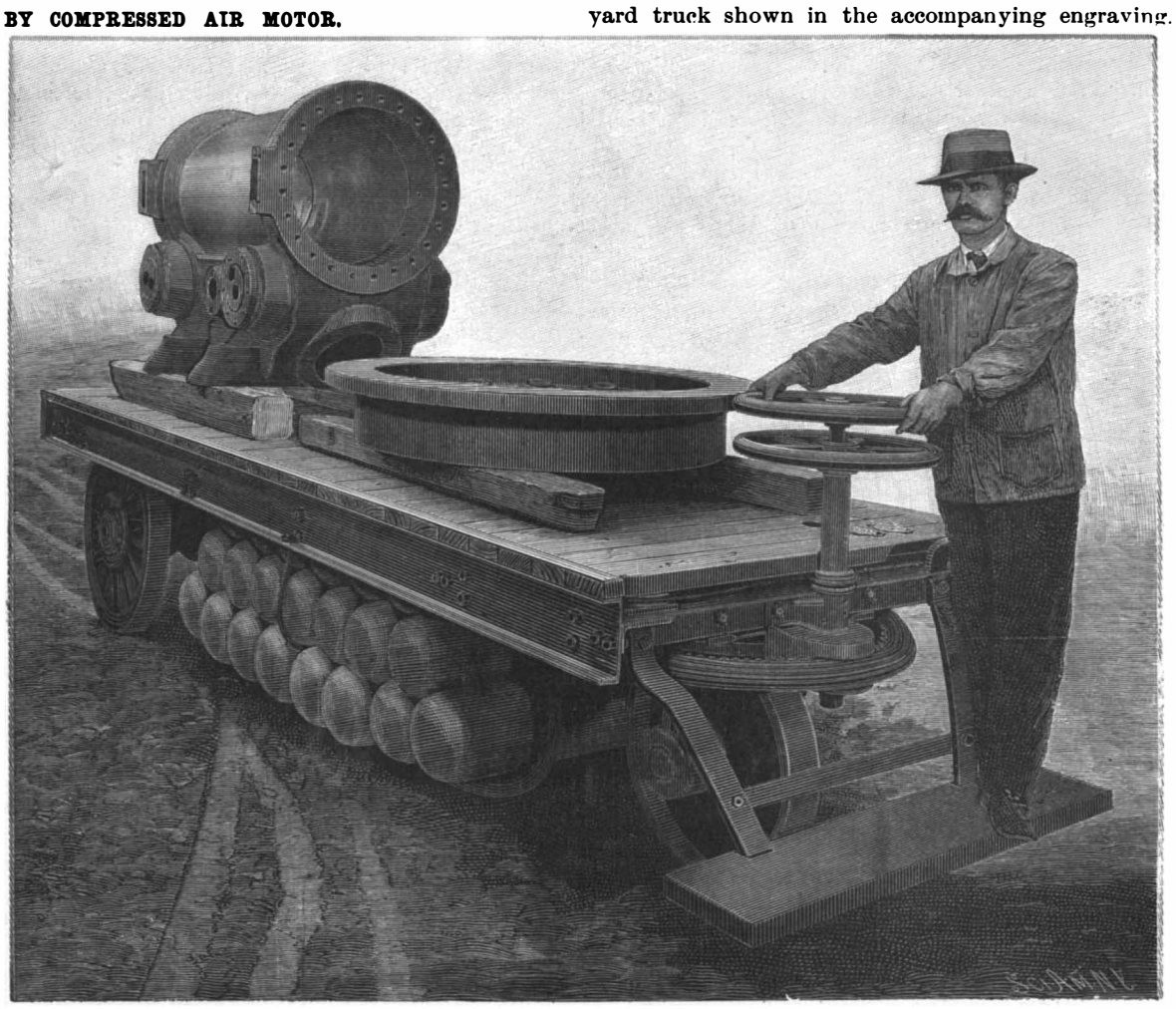
Our illustrations show a plan view and a photographic reproduction of one of the motors which was successfully at work on the Lenox Avenue line. It will be seen that the truck is of the type ordinarily used for electric cars, and it is one of the advantages of this compressed air motor that it does not involve any structural alterations to the truck to put it in place. The weight of the car when it is equipped is about the same as that of an electric car, the car body weighing 6,500 pounds, the truck 4,500 pounds, the reservoirs 3,600 pounds, the complete motor 3,000 pounds, and the other fittings bringing the total weight of the car up to between 18,000 and 19,000 pounds.

It will be seen from the plans that the power is applied to both axles, the high pressure cylinders driving one axle and the low pressure cylinders the other. The cylinders are, in each case, attached to the outside of a strong, cast-steel casing, which entirely incloses the moving parts of the motors. The lower part of the casings in each case serves to hold a bath of oil, which renders the engine self-lubricating and, because of the close-fitting cover, entirely dust-proof. The high pressure cylinders are 4 inches in diameter, the low pressure cylinders 8 inches, and the common stroke is 6 inches. The crankshaft carries a 9-inch pinion which meshes into a 23-inch gear-wheel on the axle of the car. The hot water tank is placed transversely to the truck and between the cylinders, as shown in the engraving of the complete truck. The supply of compressed air, stored at 2,400 pounds pressure, is carried in a set of cylindrical steel reservoirs, which are placed beneath the seats in the car. From these it is led by a combined throttle and reducing valve, at a pressure of 320 pounds to the square inch, to a coil which is located within the hot water tank, in which the water is under a pressure of between 225 and 300 pounds to the square inch. In passing through the coil the temperature of the air is raised to an extent which greatly increases its capacity. On its way from the coil to the high pressure cylinder a spray of hot water is thrown into the now heated air, in which it is immediately converted into vapor. The combined steam and compressed air then enter the high pressure cylinder. The high pressure exhaust is heated by passing it through the hot water coil, and before the reheated air enters the low pressure cylinders, another spray of hot water is injected into it. The temperature of the air as it issues from the low pressure exhaust is sufficient to prevent any trouble from freezing and choking up the exhaust passages.

AUTOMOBILE CARRIAGE DRIVEN BY COMPRESSED AIR MOTOR.

The power is controlled by a single lever at either end of the car. When it is thrown over in one direction, the car is propelled at a speed corresponding to the distance through which the lever is moved. When the lever is reversed, the car is stopped, and a further movement in the reverse direction will reverse the motors. With regard to efficiency, it may be said that, in the diagrams showing the work of compression and expansion, the area of the compression cards is 2·015 square inches, and the area of the cards of both high and low pressure cylinders is 1·227 square inches; from which it is seen the compound compressed air motor shows an efficiency of 60·9. It has been found that, owing to certain losses not shown in the diagrams, as a matter of fact, about 35 per cent of the indicated power of the compressors is delivered on the axle of the car in driving the motor. Fifty per cent of this economy is estimated to be due to the reheater and careful tests have shown that the cost of reheating is about one-fifth the cost of compressing the air. It requires thirty to forty pounds of free air to drive a nine-ton twenty-four foot car, and the cost of compressing and reheating the air and of the maintenance of the motor works out as 2·9 cents per car mile.

In view of the large amount of publicity which has been given during the last few weeks to the financial affairs of the motor company and what is known as the auto-truck company, the public would naturally be led to suppose that the auto-truck was in successful service on the streets of our large cities. This is not the case. The only actual compressed air auto-truck in existence as far as we have been able to learn is the crude yard truck shown in the accompanying engraving.



EXPERIMENTAL COMPRESSED AIR AUTO-TRUCK FOR YARD.

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The Hoadley-Knight motor, it is true, has been applied to an automobile carriage of the kind shown in our engraving, which has the appearance of being a compact and serviceable vehicle; but the auto-truck, so called, exists as yet only upon paper. Plans, however, have been prepared and the company has purchased the Rhode Island Locomotive Works for the purpose of manufacturing cars and motors.

Report of the Smithsonian Institution.

The report of Prof. S. P. Langley, Secretary of the Smithsonian Institution, for the year ending June 30, 1898, has just appeared. Following the precedent of several years, he has in the body of the report given a general account of the affairs of the Institution and its bureaus, and, as usual, the report teems with interesting particulars of the splendid work which is to be accomplished by this branch of the government service. The receipts for the year were $67,178.22, of which $56,400 was derived from the interest of the permanent fund in the Treasury and $10,778.22 was received from miscellaneous sources. The total permanent fund now amounts to $912,000 and is deposited in the Treasury of the United States. During the year 1897-98, Congress charged the Institution with the disbursement of appropriations for exchanges, ethnology, the preservation of the National Museum, the preservation and care of the collections, maintenance of the buildings of the National Zoological Park, the Astro-Physical Observatory, etc., in all $363,097.

The promotion of original research has always been one of the proper functions of the Institution. Investigations in the anthropological, biological, and geological divisions of science have been extensively carried on through the departments of the National Museum and through the Bureau of American Ethnology, these lines of research being well represented by its bureaus. It has remained for the Institution proper to devote its energies more specially to some of the physical sciences. The secretary himself has carried on researches in the solar spectrum which are believed to be important, and the results of which will shortly be published. The secretary has not wholly discontinued the studies he has made in regard to aerodromic experiments, and these have attracted the attention of other departments so far that during the war with Spain a commission was directed by the Secretaries of War and the Navy to inquire into them with a view of their possible utility in war. The secretary's time is now so largely given up to administrative work that what he has been able to do in these directions has been largely done in hours which might be considered his own. Grants were made from the Hodgkins Fund for carrying on work at the Blue Hill Meteorological Observatory and to a number of professors at home and abroad for carrying on investigations upon the air and other gases.

In the plan of organization of the Institution, exploration occupies an important part, and during the year investigations among American Indians have been conducted by the Bureau of Ethnology, and several collaborators of the Institution have made natural history explorations. As usual, the Institution has published a number of interesting books and pamphlets, among which may be specially noted Dr. H. C. Bolton's "Catalogue of Scientific and Technical Periodicals," a monumental work, second only to his "Bibliography of Chemistry." The library quarters at the National Museum have been increased, and during the year nearly 5,000 volumes were added. The Smithsonian deposit at the Library of Congress is known to number something like 350,000 titles, and the work of classification and cataloguing is being actively carried on.

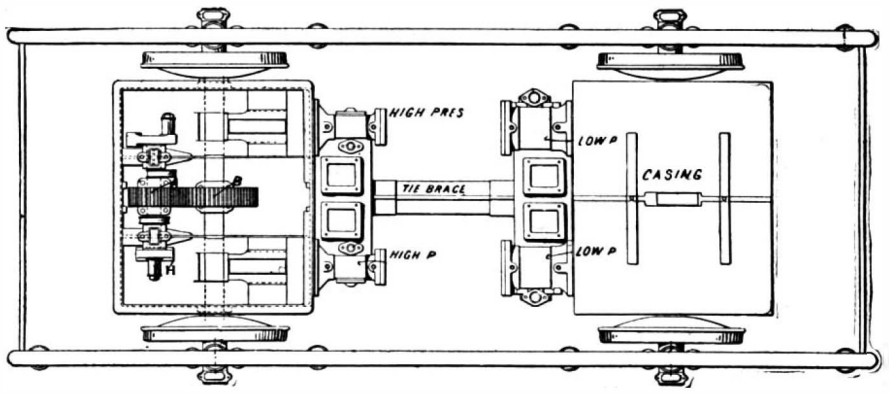
At the International Congress of Orientalists, which was held in Paris, September, 1897, and at the International Geological Congress, held at St. Petersburg, September, 1897, the Smithsonian Institution was represented by delegates. The Institution participated in the Tennessee Exposition by a proper exhibit. The National Museum has, during the year, received 4,141 lots of specimens, which include more than 450,000 objects. This is worthy of special notice, as this increase is the largest during the last fifteen years, and it manifests a desire on the part of the public to aid in building up the collections. The number of specimens now recorded in all departments of the Museum is considerably more than 4,000,000. Nine thousand four hundred and fourteen institutions in other countries are in communication with institutions in the United States through the Smithsonian Institution, and the Report is accompanied by a map showing the distribution of correspondence of the Smithsonian international exchange services. The weight of matter sent out during the year exceeded 150 tons and was distributed among 93 countries. Work has also proceeded on the National Zoological Park and at the Astro-Physical Laboratory. The amount of work carried on by the Smithsonian Institution is enormous, and the quality of it is so high that there is no branch of the government service which is so widely and warmly recognized abroad as the Smithsonian.

Patented Works at the Paris Exposition.

Fears have been entertained by some American manufacturers, who intend to have exhibits at the Paris Exposition, that their inventions, registered designs, trade marks, etc., will not be protected by the French government. It is satisfactory to note that Mr. A. S. Capehart, Director of the Liberal Arts and Chemical Industries for the United States Commission to the Exposition, who recently returned from Paris, states that he was assured that the inventions, trade marks, etc., of the American exhibitors would be amply protected. Mr. Capehart has obtained considerable information in regard to the subject from the French authorities, which he will publish in a pamphlet which will be issued by the commission for distribution among manufacturers. He states that the French law of 1868 is explicit, and that this law is incorporated in the organic act of the republic providing for the exposition. The law is in relation to all exhibitors, and guarantees ample protection to those who have not previously exhibited their manufactured articles in the republic of France for a period of three calendar months next following the close of the exposition, provided such exhibitor, within thirty days after the opening of such exposition, make or shall have made application for a patent. Mr. Capehart also quoted from the general rules and regulations of the exposition. In the chapter concerning the protection of the exhibits are the following provisions:

Section 70. No works of art, no products exhibited in the buildings, parks, or gardens, may be sketched, copied, or reproduced, in any way whatsoever, without an authorization from the exhibitor countersigned by the department of the director-general. The commissioner-general may give permits for the reproduction of ensemble views.

Section 71. Exhibitors shall have all the rights and immunities granted by the law of May 23, 1868, as to the guarantee of inventions liable to be patented, and also of manufacturing designs, within the delays and subject to the conditions of the said law.



PLAN SHOWING ARRANGEMENT OF MOTORS, GEARING, AND CASING.

Gun Metal for Jewelry.

Gun metal is at the present time very popular for match boxes, cigarette cases, watch cases, lorgnettes, etc., for which silver has been the prime favorite for several years. The New York Tribune recently had an interesting article on the subject.

Gun metal is made up not only in plain, undecorated form, but also in combination with gold, and is used in the handsomest pieces as a background for jewels. A quantity of gun-metal jewelry was imported from Europe a few months ago. A few manufacturers at once began experiments with a view to duplicating the same, but they soon found themselves not successful in obtaining the dull, soft luster which distinguishes the blackish surface of the metal. Lacquering, oxidizing, and varnish failed to give the desired finish, and the coatings wore off very rapidly, and for a while it seemed as though the foreigners would enjoy their monopoly; but at last an Italian who had been engaged many years in making fine jewelry in gold and silver, after a long series of experiments discovered the process, and, strange to say, he is almost the only man who can now produce a satisfactory article of this kind in this country. Naturally, he will not disclose the valuable secret, but he gave the writer of the article referred to a general idea of the method of treating the metal. He first procures the high-grade steel used by the government in the manufacture of artillery, so that it is really "gun metal," and proceeds to fashion it into the various forms desired. The metal is then, of course, of the ordinary light gray color which characterizes steel, and to produce the dull black luster a long process of finishing must be undertaken. The workers refer to the first step in the process as "taking all the rust off the metal." This is done by boiling it in hot acids. After being soaked for some time in one solution, the article is taken out and dried, when the rust appears upon it as a dull, reddish-brown coating. This is then filed off. After every trace of brown has been removed, the piece is immersed in a second solution, taken out, dried, and filed as before. These alternating soakings and filings are repeated five or six times, until there is not a trace of rust left. The last filing and polishing leave it in the proper condition, and it is then ready for sale, unless it is to be mounted with gold or precious stones. It is very difficult to put on hinges, etc., as it is very hard to solder it properly. As only the most expert workmen can be employed, this accounts for the present very high price of the gun metal articles. It is an unfortunate quality of this beautiful substance that when exposed to much dampness it will rust after a time, despite the care with which it is made.

Viticulture in Russia.

Although the results of last year's grape harvest, especially in the Crimea, were disappointing—a fact due to unfavorable weather and to the ravages of the phylloxera—viticulture in Russia has within the last fifteen years made enormous strides, says The English Mechanic. At one time confined to the southeast of the Crimea, it now extends in a northerly and northeasterly direction into the provinces of Kherson, Podolia, and Bessarabia, some of the plantations, notably that of Prince Troubetzkoi, covering an area of 500 acres.

In the government of Bessarabia, in particular, the progress made, according to the acting British consul-general at Odessa, has been very marked, both in the extent of land under cultivation and in the quality of wines produced. The former fact is brought out by a comparison of the area under cultivation in 1893, which amounted to 108,000 acres, and that in 1897, which was 175,000 acres. The latter fact is evident when we consider that a province which at one time produced only wine rated as very inferior has now gained a reputation for the quality of its superior wines, which are quite equal to good quality French wines, over which they have a considerable advantage in point of price.

The causes militating against the wine harvest in the Crimea have also been present in Bessarabia, so that the finer quality wines are this year more limited in quantity and higher in price than in a good season. The quality of the Bessarabian wines, both red and white—the red bearing a close resemblance to Burgundy, the white partaking of the nature of hock—should render them acceptable in England and other countries, and it is confidently believed that in course of time Russian wine will compete with effect on the markets of Europe; in fact, it may be worthy of note that it figured in 1897 among the exports from South Russia, when the first shipment of the kind was made to the British Isles. The development of viticulture has led to the establishment in Odessa of two champagne factories. One of these has not yet commenced operations, but the other has been working under most favorable circumstances for some time, competing most successfully with French champagne.

The Launching of the Cruiser "Albany."

The United States cruiser "Albany," which was purchased from Brazil about the middle of last March, was launched at Newcastle, England, on January 14. The vessel is the sister ship of the "New Orleans," which we have illustrated in the SCIENTIFIC AMERICAN for April 9, 1898. Her length is 330 feet; the moulded breadth is 43 feet 9 inches; the maximum draught is 16 feet 10 inches; her displacement is 3,600 tons; the horse power is 7,500; and the coal capacity is 850 tons, giving a steaming radius of 8,000 miles. The armament consists of six 6-inch rapid-fire guns, four 4·7-inch rapid-fire guns in the main battery. The secondary battery is composed of ten 6-pounders, four 1-pounders and four Maxim rapid-fire guns. The cruiser is also fitted with three torpedo tubes. Fortunately the vessel was purchased at a time when the construction could be altered somewhat to adapt the vessel to our needs. The improvements are largely in the matter of ammunition hoists and in providing more comfortable quarters for the officers and crew, as a vessel which is intended for the tropics is very uncomfortable in our northern climate, as has been found in the case of the "New Orleans," which was built for use in southern waters.

SZCZEPANIK, the Polish schoolmaster, who is the alleged inventor of the alleged instrument for enabling one to see an object at a distance clothed in the colors of nature, announces that by means of an electrical device which he has invented, he can, by it, with the aid of a beam of light, explode bombshells. Our contemporary The Electrical Engineer, from which we glean this interesting intelligence, calls this "another fern from Szczepanik's garden." The instrument which is supposed to annihilate distance and enable us to see our friends in foreign lands is known as the "fernschr."

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Correspondence.

Metallic Copper in Trees.

To the Editor of the SCIENTIFIC AMERICAN:

In a recent number of the SCIENTIFIC AMERICAN, reference was made to the occurrence of muriate of copper in the roots of pine trees. A peculiar case of the occurrence of copper in the plant world fell under my observation recently. An oak tree died in one of the parks of the city of Minneapolis, and while cutting up and removing the trunk, a peculiar copper-colored powder was noticed as coming from the wood. So remarkably bright and beautiful and so abundant was this powder, that it immediately attracted attention. Analyses indicated almost pure copper. Under the microscope, the powder appeared as flakes, the larger ones partly rolled up so as to fit in the pores of the wood. Some of these larger flakes, when unrolled, measured one and a half millimeters in diameter.

Analyses of the wood showed certain parts of the tree to contain comparatively large quantities of the metal, while other parts contained only a trace. The outer rings contained nearly all of the metal, the heart and the inner annual rings containing only a trace. The maximum amount of copper seemed to be in the fourth and fifth annual rings from the bark. This part of the tree contained 4 milligrammes of copper per 100 grammes of wood. The origin of the metal has not yet been determined.

GEORGE BELL FRANKFORTER.

University of Minnesota, January 16, 1899.

Experiments in Aerial Navigation.

To the Editor of the SCIENTIFIC AMERICAN:

The announcement that the government of the United States has appropriated $25,000 for experiments in aerial navigation by the Board of Ordnance, under direction of General Greely, Chief Signal Officer, cannot but stimulate inventors. This is the first time in our history that any money has been directly appropriated for such purpose.

Two months before the opening of our war with Spain, in communications to the Secretary of War and to the Chief Signal Officer, I urgently recommended the construction of several war balloons for captive observations, and the creation of at least one aerial warship for observation and assault, to combine all the then existing features of known value practically attainable.

The answer was that whereas the great advantages of a practical airship were realized, yet the department had then no funds for either construction of or experiments with an airship, and that in the matter of balloons, should the necessity arise, I would be further communicated with. The war followed, and found us utterly unprepared in the matter of aerial warfare and almost the same as to captive balloons for observation. As a result, I was called upon to speedily build twenty-one captive war balloons, ranging from the largest size suitable for such work to those exclusively used for signaling. Our war was too brief to bring these into action otherwise than as practicing apparatus for the balloon corps, under instruction of one of my selected aeronauts, at Tampa, Fla.

With an efficient apparatus, already in order, it was among the easy possibilities to discover Cervera's fleet lying snug in Santiago Harbor, instead of our worrying weeks about a spook fleet threatening our coast, and wasting time and money in non-discovery, to say nothing of our chance of early observation, and interception and capture without destroying it, as it escaped from Santiago Harbor.

Our limited aeronautical equipment permitted only a preliminary observation of the defenses of Santiago by our balloon signal corps just before the assault. Was the subsequent advance of our captive balloon 80 yards in front of our columns a shrewd "Yankee trick" to draw the Spanish fire, and thereby distract the aim of their Mausers and artillery from our assaulting troops, by offering instead this alluring sky target for their practice at short range? This balloon banner was thus as much in evidence and bore its bullet marks as bravely in the front of battle as any other standard, though it finally fell, wounded but not destroyed.

As a matter of fact, under fair conditions, it is very difficult to hit a distant captive balloon, and scarcely possible to hit any balloon sailing free and high in air, and any wounds, however inflicted, can be repaired by a competent operative.

Our past experience illustrates anew the old saying, "In time of peace prepare for war." With funds now available, there is a great natural curiosity to know what may be done with them. Two systems present themselves for attaining aerial navigation. One, mechanical flight, by wings or aeroplanes and screw propellers. The other, a gas-buoyed vessel propelled by any means. Mechanical flight has troubled men's minds for centuries before the balloon appeared. The balloon is the only means by which man has yet risen free from the ground.

Of late costly experiments have been made with propelled aeroplanes, without achieving practical success in carrying man aloft. Maxim, who has spent more money on the aeroplane than any other man, over $100,000, it is reported, recently declared in his lecture in New York, reported in the SCIENTIFIC AMERICAN, December 24, as a result of his experiments, that "the aeroplane system would not be found successful, but that a totally different plan would be necessary," the conditions attending a toy experiment not being akin to larger operations. Furthermore, he declares that in his opinion the sum of "$25,000 will be found completely inadequate" to properly attempt the subject, and that $100,000 or more will be necessary.

My own experiments, which include both of the systems, corroborate those of Maxim, though not approaching them in the matter of large expenditures upon the aeroplane alone. Indeed, I do not think that large expenditure is necessary in any experimental system for aerial navigation, as most of the tests are simple and may be cheaply made, and quite as successfully in a small way as if larger. In this field I believe it to be a fact that what will not succeed in a small way will not in a large way, so far as relates to mechanical flight or aeroplane buoyancy. The chief difficulty in aeroplane flight is the fact that buoyancy is entirely dependent upon aerial resistance, and this resistance devours force.

To illustrate: From common observation it would seem that if a thin lath (1 inch by 4 feet) were to be buoyed up by its swift passage through air, it should naturally be projected lengthwise, like an arrow. The facts are directly otherwise. The lath projected lengthwise would chiefly meet resistance and be buoyed up by the air first touching its front under edge or surface, one inch wide, the remaining portion, trailing rearward, being comparatively of little use, because not meeting much resistance. On the other hand, if the whole long edge of the lath be projected broadside, with this front edge slightly elevated, it would be buoyed up along the whole 48 inches. Its resistance would, however, be much greater than one inch, say 48 times as much, roughly speaking, but the entire weight of the apparatus relative to effective buoyant surface would be less than with the first experiment.

The construction of a bird's wing is based on this law, and it is composed of single narrow feathers, which are in turn composed of minute slats, like common blinds, overlapping and separable, and capable of presenting many times the effective aerial resistance of a single united surface.

This mode of wing or aeroplane construction has limitations, however, and its economically effective range does not appear to exceed 2 inches in width for any bird's feathers, while the wing of the largest bird seldom exceeds a few inches in width and is never a few feet wide from front to rear when extended in flight. The only resource, then, is in the multiplication of wings or feathers or lath surface drifting edgewise, upborne by aerial resistance. The effective aeroplane must of necessity become a vast, subdivided, and complex system, possessing great surface in order to buoy up great weights, and this requires powerful propelling force sustaining it in swift flight, as it cannot pause a single instant without falling. Besides its effective buoyant surface, its power mechanism and propellers possess bulk, and consequently resisting surface not available for buoyancy. These observed facts have been the result of considerable practical experimenting which cost me more time than money. I regard them as inevitable and opposing conditions.

Surface being the chief resisting factor, I next sought how to evade resistance. Given a necessary body, hull or case for containing passengers, goods, and appliances for buoyancy or propulsion, what form should this body have? This inquiry seems to have escaped the research of most flying machine fanatics.

I began by building various forms of bodies and dragging them through still water or immersing them in water currents while held by simple spring scales to note the comparative pull or resistance. I next built buoyant gas models like those forms found most valuable, and towed or floated them in air currents, attached to spring scales for noting comparative pull. All these were quite early experiments, and showed me that the two elements, air and water, were vastly different mediums in their influence on hulls of vessels completely immersed in them.

These experiments were followed by a series for testing swifter flights of bodies, including all forms of projectiles, of equal weight and sectional area, impelled by ramrods fired from a spring gun of known force, for accurate comparison. Incidentally these bodies were fired into air, water, snow, sand, wood, ice, and metal plates. They revealed one fact which is a scathing criticism upon our imbecile system of modern bullets and cannon balls. It was known at this time that if a slug or cylinder required or consumed a certain force in overcoming air resistance, say for comparison 6 pounds, then a globe or hemisphere might only consume one-half this force, or 3 pounds, while a cone of same sectional area might only need one-third of this force, or 2 pounds. Here investigation seemed to have stopped, though it is evident that the sharper a cutting tool or projectile became, the more effectively it could cut or pierce, if well supported. Now it would seem, certainly, that if a needle could not be improved by breaking off its point, or a razor by dulling its edge, or a cold chisel by cutting its tooth off square across, then a bullet would not have increased penetrating power by treating it likewise.

Whatever the practical reasons may be for these obtuse forms of projectiles in use, it became quickly evident that for aerial navigation a tub or a globe or cone was unsuitable, and that it was of the utmost importance to create a new form of air-piercing projectile whose bulk or uncouth form would not be a serious feature when speed or economy in driving power was desired. The problem finally narrowed itself to one of extreme simplicity—the evolution of an entirely new air vessel or projectile which evaded all aerial resistance in theory, by having the ability to convert the resistance or air pressure in front to an equally propelling influence applied to the rear to urge it forward in equal degree. This I practically attained in a symmetrical vessel containing and braced by hydrogen for preservation of form and buoyancy, with space for other requisites, as motive power and supplies. This body resolves itself into a mathematical formula, governed entirely by the two elements of its length and breadth, or speed versus carrying power, great relative bulk being impracticable with high speed as a purely physical and mathematical fact.

The success of aerial navigation at this moment seems to be dependent upon a practical light motive power, of great force, and not upon any mystery of bird's flight, or sustaining power of aeroplanes or special forms of screw or other propulsion. No complex system of surface buoyancy known at present has equaled the work or prolonged stay in the air of the ordinary hydrogen balloon, while with equal motive power the gas vessel of superior form will give more prolonged results, cover greater distance, carry greater weights, and entail more safety for the passenger than can the best aeroplane, using equal power and carrying a passenger. With the 300 horse power steam motor of Maxim many of the gas vessel systems invented in this country could have made a better showing than has any mechanical flight or propelled aeroplane system thus far shown, the one fatal defect of all such systems being the inability to safely stop or hover in the air. It constantly risks destruction through irregularities or perturbations in air currents, or turmoils in the air, while the gas vessel itself is becalmed during any storm when it ceases to urge itself forward or struggle against it. Its endurance becomes a matter of gas-holding power. Absolute imperviousness is insured, not by any special varnish, but simply by superimposed, multiple tissues of suitable varnish applied by machinery, by which all underlying microscopic pores are plugged up and overlaid by many succeeding films too thin to reveal their total bulk to a micrometer caliper, yet denser than hydrogen and holding it prisoner. Hydrogen balloons built by me within the past year had from eight to twelve such coats, with little increased weight after the first two coats, because applied smoothly and homogeneously, with every particle of surplus varnish removed to insure only the thinnest films, which are generally as effective as if thicker. Long voyages with gas vessels henceforth may depend entirely upon expert manipulation of supplies carried, as with suitable treatment little gas or ballast need be expelled.

CARL E. MYERS.

Frankfort, N. Y.

A Refrigerating Plant for Manila.

The Chief Quartermaster of the Department of the Great Lakes, U. S. A., has invited proposals for the erection of a large refrigerating plant at Manila, for the use of the commissary department of the United States army in the Philippines. The plant as designed will be one of the largest of the kind ever built, and will include a number of ice-making machines and equipment for a large cold-storage plant. The estimated cost of the apparatus will be $100,000. The cold-storage rooms will have a capacity of 1,200 tons of beef and 150 tons of mutton, 100 tons of vegetables, 50 tons of butter, and 50 tons of canned goods. Special rooms are to be built for every class of supplies, so that they will be kept in good condition for months in the tropical climate. Under this arrangement soldiers at all times will be furnished with fresh meat and other foods. The plant must be ready for use within six months after the contract is awarded. Bids will be opened on February 1.

Death of the Builder of the Transcaspian Railway.

Gen. Michael Annenkoff, the distinguished Russian engineer, who constructed the Transcaspian Railway, is dead. He was born in 1838 and had a military career. He was later assigned to the work of constructing strategetic railways, and he soon distinguished himself in this direction. He completed the great Transcaspian line. He was noted for the ingenuity and the process of construction which he employed and the rapidity with which they were carried on.

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INVESTIGATIONS AT THE KEELY LABORATORY.

In our last issue we noted the fact that the Keely laboratory, at 1420 North Twentieth Street, Philadelphia, Pa., had been examined by experts, and that the discoveries seemed to confirm the views held by the SCIENTIFIC AMERICAN in 1884, that the phenomena were produced through the medium of compressed air. A representative of the SCIENTIFIC AMERICAN was at once sent to Philadelphia, and through the courtesy of Mr. Clarence B. Moore, who has the lease of the premises, unique photographs and diagrams were obtained.

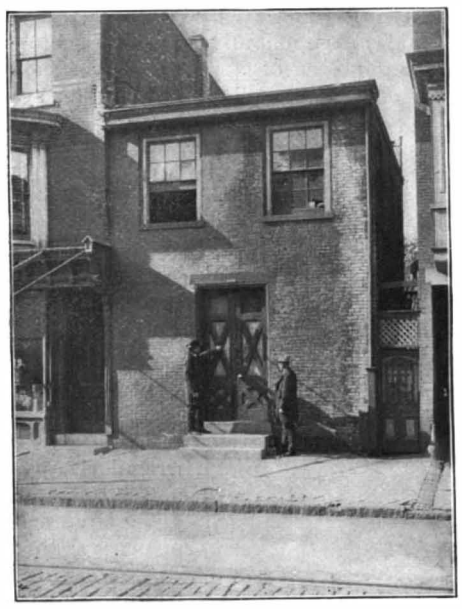
The laboratory is an inconspicuous brick building two stories in height. After Mr. Keely's death the laboratory was given up, and all the apparatus, wires, tubing, etc., in fact, everything which could be used as a clew to the discovery of the principles underlying the alleged motor, but it is shown by the result that Keely had not taken anyone into his confidence, and accounts for even his supporters being ignorant of the existence of the remarkable things which we are to describe.

The investigations were carried out under the auspices of the Philadelphia Press.

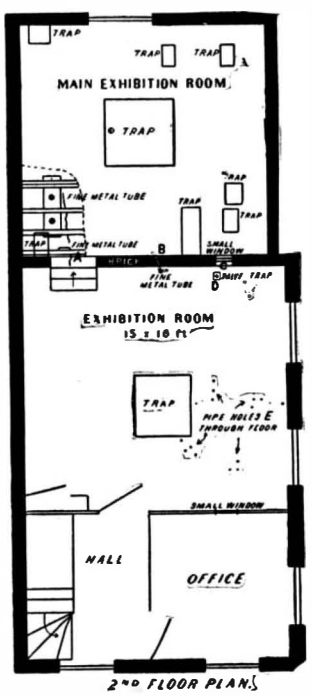
Every bit of flooring was ripped up and every nook and cranny explored in the floors, walls, and ceilings, and it was found that the building was honeycombed with traps, holes for piping, etc., for carrying on the bogus experiments. Everything was conducted with such secrecy and ceremony, and the laboratory lent itself so admirably to the purposes of deception, that it is little wonder that this nineteenth century thaumaturgist should have been successful, for the border line between science and quackery is always attractive.

The ground floor has no cellar under it and at places the joists were sawn away and the flooring had been removed and replaced in sections, forming what is known in stage parlance as "traps." Most of the spaces between the sawed joists were filled with ashes, and here valuable finds of tubing and connections were made. The center room contains four traps and a pit. Back of this was a room to which no one was ever admitted, and here a remarkable discovery was made. A steel sphere forty inches in diameter, weighing 6,625 pounds, was found embedded in a pit underneath a trap. The sphere had two projections or trunnions: both had a hole through them; one of these holes had been filled up and then faced off, and the other, near the iron pipe shown in our small illustration, was open and was of the proper size for charging the reservoir. Midway between the two trunnions a small hole drilled into the side of the sphere was found to be the proper size for connecting with one of the small brass tubes connecting with the second story. These tubes, while of small diameter and having a small bore, have very thick walls, showing that they could resist enormous pressure. Of course, the sphere possessed great strength and must have been an ideal storage reservoir for air or gas at a great pressure. William Rickert, who was formerly employed in Keely's laboratory, has come forward with valuable evidence. He says he helped to test the steel sphere with a hydraulic pump which was specially made for the purpose. It was tested up to 28,000 pounds, or only one ton less than the powder chamber pressure required in tests of United States ordnance. Steel tubes were also tested with this powerful hydraulic pump. The tubes were 9 inches in diameter and the bore was only 3 inches. These were split with enormous pressure and the stockholders and the general public believed that the tubes were burst by the "etheric vapor." Mr. Rickert states that they ran tubes to the lever machine which indicated pressure, and one of the tubes recently discovered Mr. Rickert believes to be a tube running to that machine. He also states that Keely never allowed the men to entirely complete any connection to the machinery; he assumed that part of the business himself. A very heavy iron pipe with high pressure joints, 13½ feet long, ran diagonally under the floor to a point in a trap in the front room. This was undoubtedly used in distributing the compressed air. The room where the sphere was discovered had a wooden ceiling nailed on to the joists, while in the front room the joists were exposed. This ceiling gave 16 inches of space, which, of course, gave an excellent opportunity for running tubes or concealing apparatus. The private room in the rear was used by Mr. Keely when resting from his arduous labors and was handsomely fitted up.

The second floor was divided into an office and two exhibition rooms, where progress was reported at intervals. Sometimes the front exhibition room was used, but generally the rear exhibition room was utilized. A small window connected the exhibition rooms and also the office. Keely would station himself behind the small window, *C*, connecting the exhibition rooms, and after asking the favored few who were allowed to see the manifestations what pressure they desired or what speed they wished, depending upon the nature of the apparatus which he was then exhibiting,



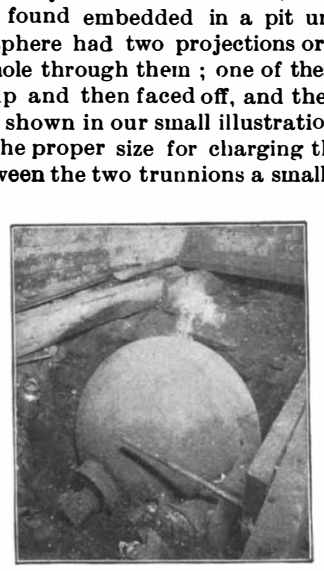
Exterior of Keely Laboratory.



2ND FLOOR PLAN.

Plan of Second Floor of Laboratory.

Front Exhibition Room, Showing Trap, Pipe Holes, and Operating Window.



Tapped End of Sphere.

Three-ton Sphere Discovered Under the Building.

Threshold of Rear Exhibition Room, Showing Concealed Tube, A.

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he would then play a violin, a zither, or a harmonica to set in motion the harmonic vibrations upon which he depended for obtaining his remarkable manifestations. The first exhibition room has many auger holes, which have been indicated by our artist. These holes were, of course, hidden by the oilcloth which covered the floor, and one of the holes was covered with a piece of tin with a hole cut out of it the same size as the auger hole, as shown in the diagram at *D*. It is surmised that these holes, and specially the last one to which we have referred, permitted the "etheric flow" of compressed air from the receiver in the cellar to the apparatus on exhibition to be controlled by a spring valve operated by the foot. Other holes seemed to have been located under the apparatus and doubtless aided in the experiments.

The upper floor of the main exhibition room was torn away during the investigation, and showed that tubing of the same kind as the alleged "wires" of Keely's lever machine passed under the joists, through the brick partition, under the threshold of the door at the point, *A*, connecting the two exhibition rooms. This is in a way the most remarkable of the find, as it was so carefully hidden in the brickwork, which had been removed and reset. The tubing ran through the brick partition under the steps, where it apparently descended into the room below, but this end was broken off. At the point, *B*, another piece of tubing was found running out into the front room from the rear room below. Those who assisted at the investigation were Prof. A. W. Goodspeed, Prof. Carl Hering, Dr. M. G. Miller, Mr. Moore and Mr. Sellers, and the investigations were so thorough and the results obtained were so satisfactory that it is to be hoped that, once for all, the Keely motor may be considered to be exposed, though we have no doubt that, like the scotched snake, the tail may still continue to wiggle.

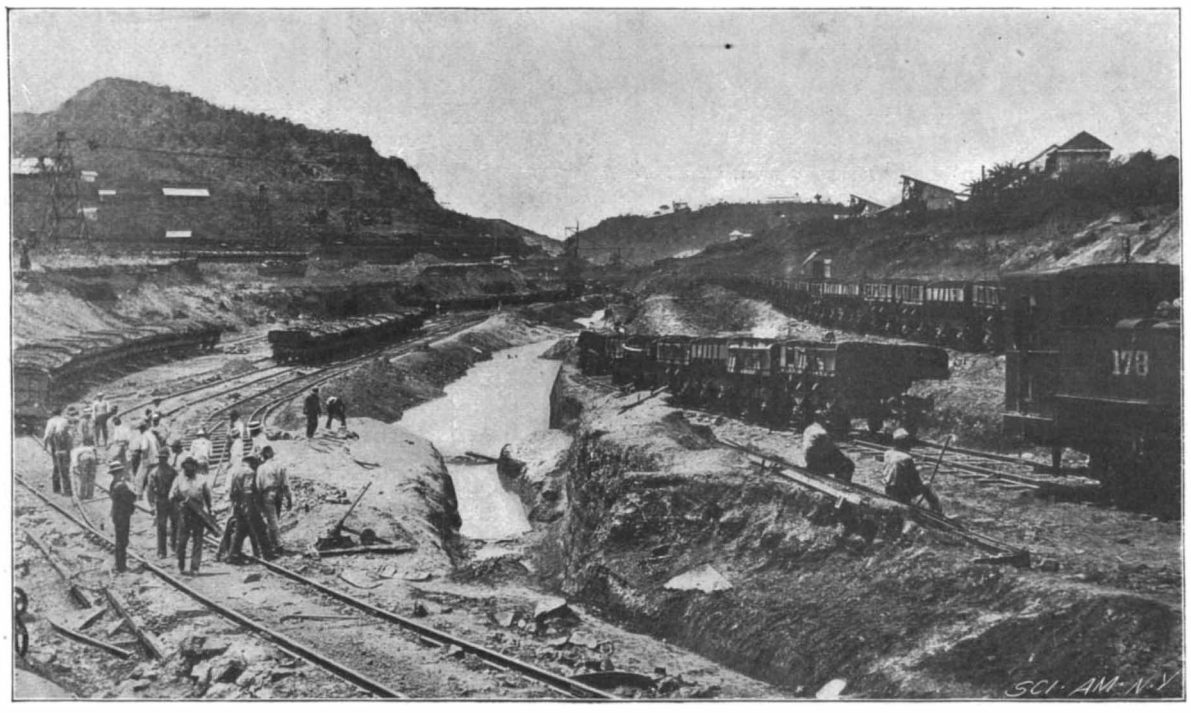
THE NEW PANAMA CANAL.

There is a broad difference between the Panama Canal as it actually is and the Panama Canal as it exists in the public mind. It would be difficult to find another great undertaking about whose present status there is so much general ignorance or positive misinformation as there is concerning the artificial waterway with which Ferdinand de Lesseps attempted to join the waters of the Atlantic and Pacific Oceans. It is a matter of history how the distinguished Frenchman, emboldened by his success in cutting the Suez Canal, undertook to open a great sea-level cutting through the mountains of the Panama Isthmus and failed—the physical difficulties of the project, assisted by gross corruption on the part of the promoters, serving to bankrupt the company when only a fragment of the sea-level scheme had been completed. The odium of that ill-considered and worse executed project still attaches in the public mind to the Panama Canal as such, and it is only the small minority, who have followed the subsequent course of events on the isthmus and are familiar with the heroic and successful attempts that have been made to bring order out of chaos, who are alive to the fact that the new Panama Canal project is on a sound engineering and financial footing and is within a calculable distance of completion.

The present article is written for the purpose of putting the public in possession of the facts regarding the present status and future prospects of this undertaking. In view of the fact that one canal at the isthmus will be amply sufficient to accommodate the traffic, the question of the completion or abandonment of the Panama scheme becomes of supreme importance in considering the advisability of building a canal on the Nicaragua route, for the construction of two practically contiguous canals would mean the bankruptcy of both.

HISTORICAL.—In 1879 an international congress met in Paris, and, after investigating various routes, recommended the building of a sea-level canal from Colon, on the Atlantic, to Panama, on the Pacific. Many of the best informed members of the congress, it should be said, considered that a sea-level scheme presented too many difficulties and advocated a canal with locks; but the influence of M. de Lesseps prevailed and the sea-level route was adopted. The calculated time for completion was set at twelve years, and the cost, including interest on capital, at $240,000,000.

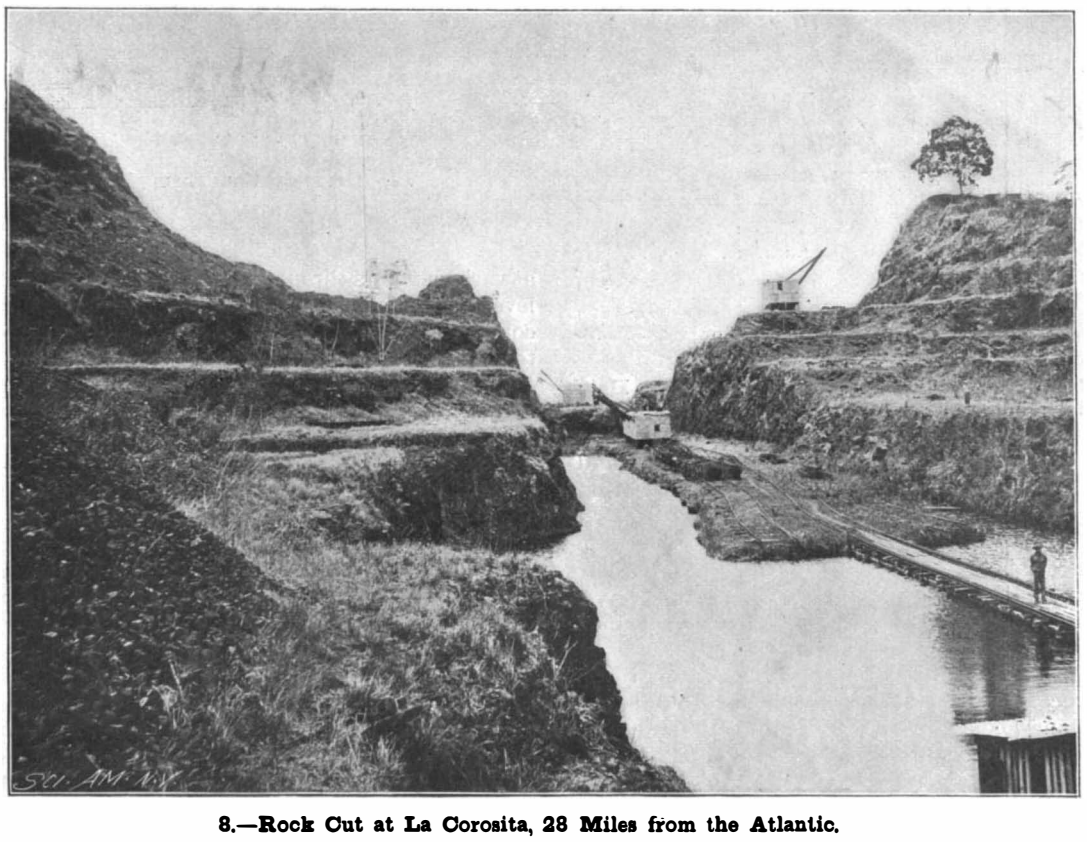
6.—French Excavators at Work in the Emperador Cut.



7.—The Work at Outlet of Culebra Cut on Pacific Slope.

Now, when it is stated that the route of the proposed canal followed for over twenty-five miles a river which in the rainy season is subjected to enormous freshets, and that in passing through the Cordillera mountains an excavation 8 miles in length and varying from 100 to 325 feet in depth had to be made, it is evident that the first duty of De Lesseps was to secure the results of careful gagings of the rainfall, and to make elaborate borings along the route of the canal to ascertain the nature of the material to be excavated. Neither of these precautions was taken, or if taken, were so incompletely carried out as to leave the engineering features of the scheme very much in the air.

Work was begun in 1881. A large amount of the capital of the company was swallowed up in purchasing and placing along the line the necessary plant, in constructing shelter for 15,000 laborers, and building the necessary workshops and hospitals. The first opening up of the surface soil induced an appalling amount of sickness, and the enormous floods of the Chagres River proved altogether beyond the control of the engineers. Moreover, the upper layers of material in the great Culebra cut proved to be of a treacher-



8.—Rock Cut at La Corosita, 28 Miles from the Atlantic.

THE NEW PANAMA CANAL.—PRESENT CONDITION OF THE WORK.

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ous character, and the side slopes caved into the excavation faster than the material could be taken out. The hopelessness of the task of building a sea-level canal was by this time apparent, and the company decided to adopt a new plan involving the construction of locks. The decision came too late. The credit of the company was not equal to the raising of further capital, and, in 1889, a receiver was appointed. At this date a sum of $156,400 000 had been expended upon the isthmus, of which about $88,600,000 had been put into excavation and embankment. The commission which examined the company's affairs states: "The enormous amount of material at hand ready to be utilized, the great number of works established, lands received, labor actually expended, experience gained, supplies laid in, preliminaries mapped out, including the right of way, are worth to the new company at least $90,000,000." The receiver obtained at this time a further extension of time from the Colombian government, carrying the date to 1904; and a later concession of six years extends the date of completion to the year 1910.

THE NEW PANAMA CANAL.—In October, 1894, a new company was formed for the purpose of completing the canal. It was organized with a cash capital of $13,000,000, and, with a view to giving it a commanding position in the financial world, the stock was purchased by several of the leading financial institutions in France, the whole $13,000,000 being actually paid in. The new company was officially recognized and its titles, etc., duly confirmed by the Colombian government.

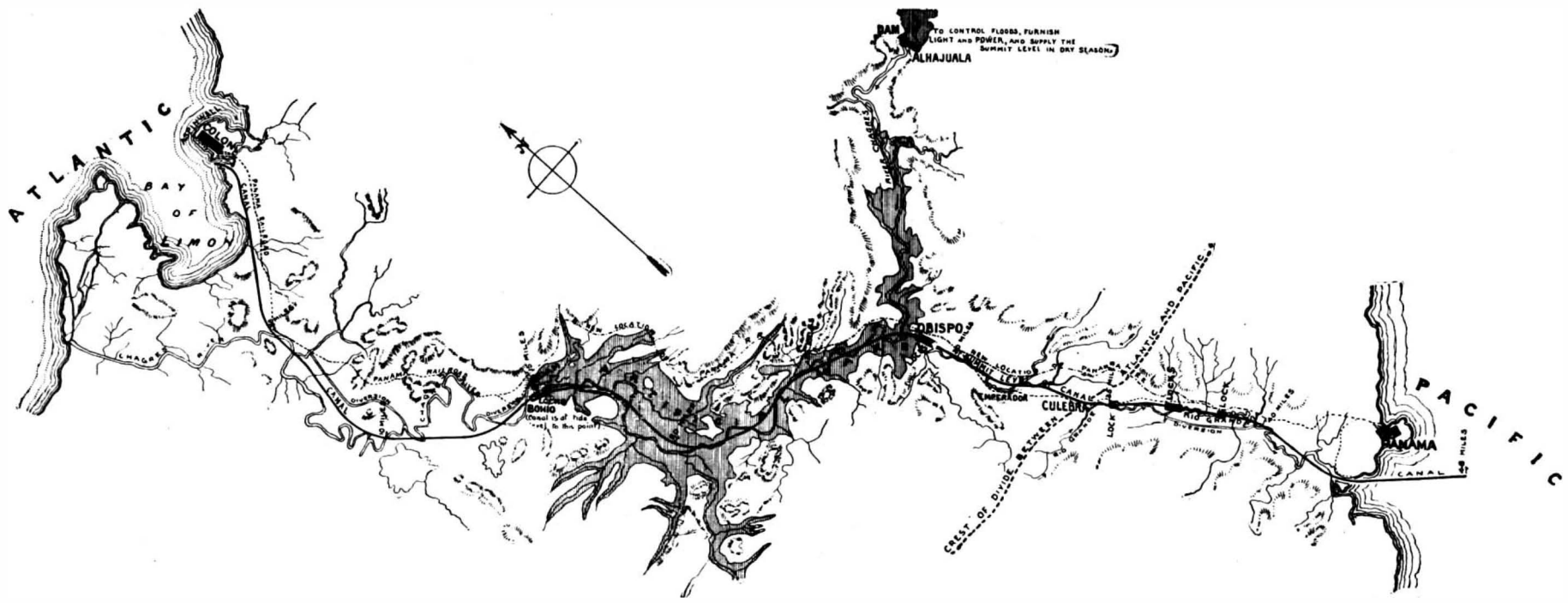
On coming into possession, the new owners very properly determined that their first duty was to make that complete study of the engineering features of the scheme, to the lack of which the failure of the old company was largely due. They also determined to begin work on a considerable scale with a view to determining exactly what quality of material would be encountered in completing the excavations and building the various dams and locks. To this end a staff of one hundred and fifty engineers was placed in the field and a force of several thousand men was put upon the work at the more important points, including the great Culebra cut through the divide.

CULEBRA CUT.—The experience of the De Lesseps engineers and the opinion of casual visitors to the Culebra cut had agreed in indicating that the caving in of the loose material would prevent this great ditch from being successfully excavated. The new company accordingly concentrated a large force at this point and at Emperador for the purpose of ascertaining the nature of the underlying material of the mountain. A tunnel 1,100 feet in length was driven along the axis of the canal and a dozen test pits 6 feet in diameter were sunk at various points through the cut down to the proposed level of the bottom of the canal, and the shafts were connected by short tunnels. In short, the mass of material to be excavated was so thoroughly honeycombed in the regions where the worst caving had occurred as to leave no doubt as to its actual composition. Altogether, in the past four years there has been taken out of the Culebra and Emperador cuts 3,924,000 cubic yards of material, and the cost of this survey by excavation has been over $4,000,000. It was costly, but absolutely necessary to an exact estimate of the feasibility and expense of completing the canal. The evidence thus acquired proves that the "Culebra sliding mountain" does not exist, the excavation having passed through the upper layer of loose material and reached an argillaceous schist, below which, to the proposed bed of the canal, is solid rock. At Emperador the material is less firm, but perfectly capable of control when provided with proper drainage—a precaution wholly neglected in the happy-go-lucky methods of the De Lesseps regime.

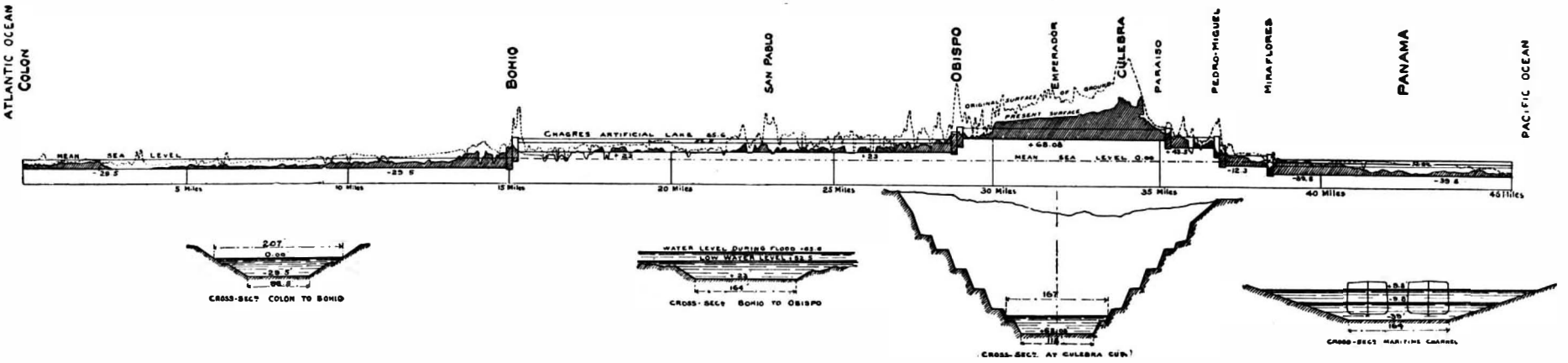
THE CONTROL OF THE RIVER CHAGRES.—Another problem to be solved by the new company was that of the control of the turbulent Chagres River. By reference to the map (Fig. 9), it will be seen that the route of the canal, immediately after passing through the divide at Culebra, follows the course of the Obispo River, a tributary of the Chagres. At Obispo the canal enters the valley through which the latter river flows, and it follows this valley from mile 29 to mile 5, a distance of 24 miles. Now during the rainy season the Chagres is liable to enormous floods, which were such as to render the canal construction on the original lines a physical impossibility.

The new company decided at the outset to abandon De Lesseps' extravagant idea of a sea level canal and substitute a system of locks. This decision opened up the question of a sufficient supply of water to compensate for losses and supply the summit level. The floods of the Chagres evidently afforded an abundant supply, and the problem then took the form of an investigation of the amount of the Chagres River discharge and the possibility of storing it in suitable reservoirs, which should at once serve to feed the summit level and to hold back the rush of the Chagres waters in times of flood. With the question of the Chagres control was associated that of the most desirable elevation for the summit level and the number and location of the various locks.

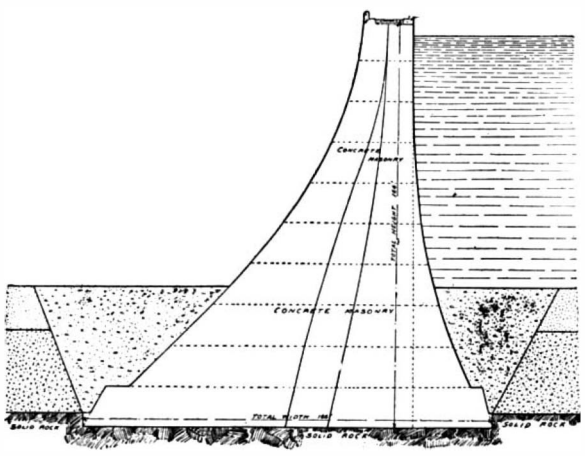
This investigation was intrusted to 150 engineers, who, with their corps of assistants, have been occupied for four years in exhaustive surveys, the total cost of which has amounted to $1,200,000. This included, in addition to superintendence of the work at Culebra, extensive borings at the sites of the proposed dams and locks, sufficient to determine the exact nature of the whole site covered by their foundations; gagings of the river; the complete cross-sectioning of the basins of the proposed storage and control reservoirs, together with every kind of research that is necessary to the determination of the feasibility and cost of an engineering work of this magnitude. The investigation has been carried out to the smallest details, the drawing of every culvert, bridge, etc., being worked out with such elaboration that, on receipt of orders to go ahead with the work, these plans could be sent to the shops and the material ordered. We have had the pleasure of inspect



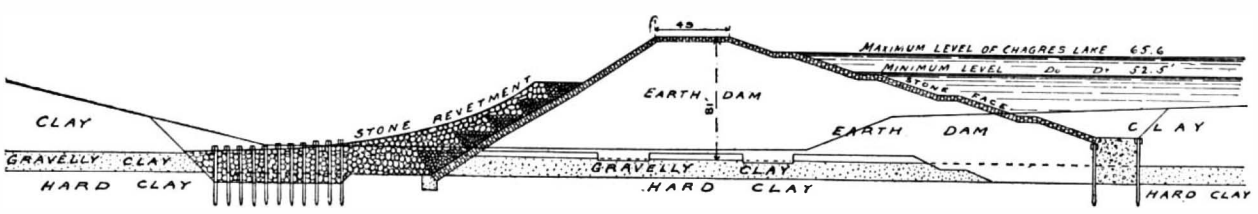
9.—General Plan of the New Panama Canal.



10.—Profile and Cross-Sections of the New Panama Canal.



11.—Cross-Section Through Alhajuela Dam. Height, 164 feet. Base, 166 feet. Length of Crest, 936·7 feet.



12.—Cross-Section Through Bohio Dam. Height, 75½ feet. Length of Crest, 1,286 feet.

THE NEW PANAMA CANAL.

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ing the engineering data, and we are free to admit that the plans, profiles, maps, shop drawings, records, etc., are as complete as the most fastidious could ask for.

The new company has evidently laid the lesson of the first failure to heart; but, in order to give further weight to the findings of the engineers, it asked for the appointment of a Technical Commission composed of eminent engineers of different nationalities, whose experience in similar work gave them special qualifications for passing upon the new surveys and plans. The International Commission included such men as Brig.-Gen. H. L. Abbot, Corps of Engineers, U. S. A.; Mr. Fulscher, formerly Engineering Director of the Kiel Canal; Mr. Koch, engineering member of the same canal; Mr. W. Henry Hunter, Chief Engineer of the Manchester Canal Company; Mr. A. Fteley, Chief Engineer Aqueduct Commissioners, New York City; Mr. C. Skalkowski, formerly Director of Mines, Russia; and four of the former General Inspectors of Roads and Bridges, France.

This commission, organized in 1896, through some of its members has made personal inspection of the canal on the Isthmus and in addition to having at its disposal the local records of rainfall and floods for the last 15 years, for two years has made its own elaborate records of rainfall and of the flow and floods of the Chagres, and has held over 100 sessions. It presented a unanimous report on December 2, 1898, which, considering the standing and experience of the members, is perhaps the most representative and authoritative document of the kind ever drawn up.

The report fully indorses the plans and estimates of cost of the new canal.

THE NEW PANAMA CANAL.—The International Commission find that the work on the canal is at present two-fifths completed, that the cost to complete the work under the new plans will be $87,000,000. If 20 per cent be added for contingencies, the total cost is $102,400,000, and the time for completion, not allowing for improvements in methods of working and plant, is from eight to ten years.

The canal is forty-six miles in length. The map (Fig. 9) shows its location, and the profile (Fig. 10) shows by a dotted line the amount of excavation that has been done and by a full line and shaded portions, the excavation remaining to be done. The engineers drew up three designs for a canal with locks. In the first the summit level was to be 96¾ feet; in the second, 68·08 feet; and in the third, 32¾ feet above the sea level. The technical commission recommends the second, which is the one shown in the map and profile.

As the determination of the levels and number of locks is dependent upon the means taken to control and utilize the Chagres River, it will be well to explain that this control is secured by constructing two large dams, one at Alhajuela, in the upper Chagres, about nine and one-third miles above the canal (see map), and the other at Bohio, at the end of the sea level length of the canal on the Atlantic side. The Bohio dam will be thrown across the Chagres valley at a point about half a mile to the left of the canal at Obispo. It will be of earth, upon a bed of compact clay. The general features are shown in the cross-section, Fig. 12. The crest is 1,286 feet long, and the extreme height above the bed of the river is 75½ feet, and above the foundation 93½ feet. This dam will create a vast artificial lake, which will extend thirteen and a half miles to Obispo. Its lowest level will be 52·5 feet and its highest level, when the river is in flood, 65·5 feet. The channel of the canal will lie in the bed of this lake, which will not only take care of a large part of the flood waters, but will greatly reduce the amount of excavation necessary for the canal. The other dam, at Alhajuela, will be built everywhere upon solid rock, and will consist of concrete masonry. Its crest, 936·75 feet long, will be 134·5 feet above the river bed, and 164 feet above the lowest foundation.

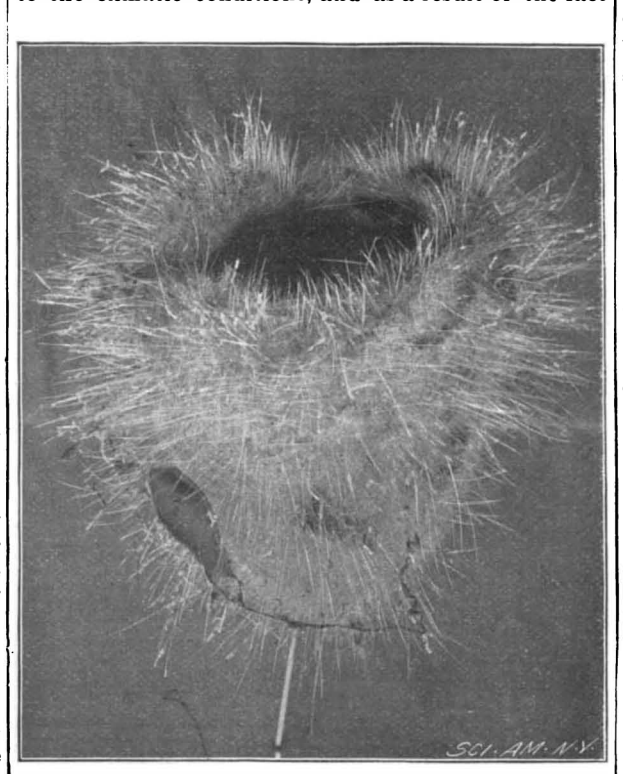
This dam will be connected with the summit level by a feeder with a capacity of 6,605 gallons per second. The dam will also furnish energy for the electric lighting of the canal and the electric operation of the locks, etc.

The storage capacity of the two artificial lakes thus formed will be 66 billion gallons, which provides a wide margin of safety, as shown by careful records, over any possible flood discharges of the river. The records of the flow of the upper Chagres have demonstrated that the surplus quantity of water impounded during the rainy season by the Alhajuela dam will be many times as great as will be necessary to supply the summit level during the dry season.

Commencing at Colon on the Atlantic, the first section of the canal, 15 miles in length, is tidal up to the two double locks at Bohio, by which vessels will pass into the Chagres River lake. These locks are of masonry and will be built upon rock foundations, as will all the locks of the canal. The deep cut shown in Fig. 3 is the site of the Bohio locks. The Obispo dam will be half a mile to the left of the locks in the bend of the Chagres River, which river is seen in the foreground of this same illustration. The working length of the locks will be 738·22 feet, the width of one of the twin locks being 82·02 feet and of the other 59·05 feet. Of this sea level stretch of the canal, the first 11·8 miles are navigable, the depth varying from 16·4 feet to 29·5 feet, the finished depth. It has been excavated to the original width (see Fig. 5), and not much dredging will be necessary to complete it for the whole 15 miles to Bohio. After passing the locks the canal channel extends for about 13½ miles along the bed of the lake to Obispo, where two double locks (built like all the other locks of the company upon a rock foundation) will admit vessels to the summit level 5 miles in length, where the bottom of the canal is 68·08 feet above mean sea level. On the Pacific slope admission is gained at Paraiso by one double lock to a level 7,963 feet in length, and at Pedro-Miguel two double locks lead down to a level 7,930 feet long, from which at Miraflores one double lock will admit vessels to the tide level of the Pacific. This portion of the canal is 7½ miles in length. The depth of water in the locks will be 29·5 feet and will not exceed 32·8 feet.

It should be noted that the slopes of the canal, particularly in the Culebra cut, are to be reveted with stone, and that the curvature of the canal is easy throughout, the smallest radius being 8,200 feet and the prevailing radius 9,843 feet.

THE QUESTION OF HEALTH.—The Technical Commission examined carefully into the question of mortality and concluded that the climatic dangers have been exaggerated. It is true that, during the first years of operation, owing to carelessness as to sanitation, the employment of races not used to hard labor in the tropics, and the fact that surface ground full of fever germs was being opened, the loss of life was serious. Of late years, however, owing to the employment of negroes from the British Antilles who are used to the climatic conditions, and as a result of the fact that the excavation is in the deeper rock formations, the amount of sickness is not abnormal.



GLASS SPONGE FROM SANTA CATALINA ISLAND, CAL.

RELATIONS OF THE NEW TO THE OLD CANAL COMPANY.—In conclusion, answering the inevitable question as to the relation of the new company to the financial burdens of the old company, we can say briefly that the old bondholders have no control over the new company, the receiver turning the property over to the latter upon the condition that the old bondholders were to have an interest in the profits (after the payment of operating expenses, depreciation, interest on construction bonds and dividend on new capital) to the extent of 60 per cent.

GLASS SPONGES.

BY PROF. CHARLES FREDERICK HOLDER.

It is not generally known that the beautiful animals known as glass sponges are found within the borders of the United States, yet one species at least is common, though rarely taken, off the coast of the Southern Californian islands, especially on the so-called grouper banks of Santa Catalina, where fishing is carried on in water five hundred or six hundred feet deep.

It was here that the attractive specimen shown in the accompanying illustration was found, being brought up on a fish hook. The sponge was a species of Holtenia, probably Holtenia Carpenteria, about twelve inches in height and nearly six in diameter; the long glass-like roots had been torn off when it was brought up. In appearance the sponge was a veritable porcupine; long needle-like spicules standing out all over it, the longest three inches in length, needles so sharp and brittle that it was difficult to hold or touch the sponge, and at a glance it resembled some odd or fanciful cactus.

The sponge was vase shaped, and would hold three pints of fluid, bulging out in the center, with an opening at the top sufficiently large to admit the closed hand. The long spicules reaching out from it presented a splendid appearance when held up to the sun, and resembled glossy hairs, gleaming and scintillating wherever the sun flashed along their surfaces. Many of the spicules were overgrown with an attractive coralline, so that they appeared branched like the limbs of a tree. In these mimic branches hung pendent many miniature pink-hued star fishes and shrimps, while fastened to them, coiled and interlaced, were the barrow-like egg cases of a skate. These are shown in the illustration.

That these sponges are fairly common in deep water offshore is evident by the small specimens often brought up and the pieces found on the outer islands, especially San Nicolas; but never before has so large and perfect a specimen been seen.

The glass sponges are so called because their skeleton, or the spicules, resemble glass, being formed of silica instead of lime, and closely resembling spun glass.

The most beautiful of the group is the Venus flower basket, or Euplectella aspergillum, which represents a vase of spun glass of the most beautiful description. When the first specimen was found it was sold at a fabulous price, and its true nature was not suspected. But finally a specimen was taken by a naturalist, who made the interesting discovery that the delicate and fragile glass-like vase, that seemed to be the work of some cunning East Indian, was nothing more nor less than the skeleton of a sponge whose spicules were silicious. In the water and alive the sponge is not an attractive object, being of a gray color and half buried in the mud, anchored by long glass-like streamers. But once dead and relieved of its covering, it becomes one of the most resplendent objects of the sea—a fairy vase, that might well have been modeled by the sea gods as a gift to Venus.

This sponge has the spicules so arranged that they present the appearance of squares. It is closed at the top and sides, hollow in the interior, and is occasionally the prison of small crustaceans, which enter the interstices when very young and unable to escape become prisoners for life, and in the skeleton may be seen with their claws protruding through the opening, creating much wonder among the uninitiated as to how they obtained ingress into the glassy prison.

Another interesting glass sponge is Hyalonema, which resembles a glass rope. The sponge itself is a small cup, perched upon a long series of glass-like stems, which is buried in the mud. This was for a long time sold as the skeleton of the little coral polyps which are parasites on its stems.

AN INSECT BREEDING IN CRUDE PETROLEUM.

BY L. O. HOWARD.

In view of the extensive use of petroleum products for insecticidal purposes, the title of this article would seem paradoxical. That such a case should be found seems, in fact, more remarkable than the breeding of the cigarette beetle, Lasioderma serricorne, in pyrethrum powder, recorded by the writer in the Proceedings of the Entomological Society of Washington, volume i., page 37.

At the meeting of the Boston Society of Natural History, January 22, 1879 (Proc. B. S. N. H., volume xx., page 134) Dr. Hagen read a letter from a Mr. Dean to Henry Edwards, of Santa Cruz County, Cal., describing a small alkaline lake in the southeastern corner of Santa Cruz County, of 20 to 30 acres area, into which copious petroleum springs continually poured their contents, which, drying, formed masses of asphaltum overlying the soil and running down to the lake. The petroleum had forced passages through the asphaltum, forming little pools of about the consistence of molasses. Mr. Dean sent with the letter a number of flies of the genus Ephydra, which he had found sitting upon the petroleum and piled up upon one another in vast numbers just like flies upon molasses, those underneath dying and becoming embedded in the petroleum and being succeeded by others, which, in turn, were pressed down into the liquid tar by those above. On approaching they would rise in a cloud about 2 feet above the petroleum, and, on being unmolested, would return and settle upon it. The dead flies were said to rise several inches deep above the liquid petroleum. Mr. Dean further stated that the flies appear to breed upon the water plants covering the surface of the lake, which are left incrusted with the salt and covered with the empty shells of the insects.

This is the only published note with which the writer is familiar which approaches in any way or is related to the case which he is about to describe. There seems no doubt, however, that in this case the insect was a true Ephydra, possibly E. californica of Packard, which breeds upon water plants in the alkaline lakes of the far Western States.

On May 20 of the past year the writer received a letter from Mr. C. G. Kellogg, Secretary of the Board of Horticultural Commissioners for Los Angeles County, of Los Angeles, Cal., transmitting in alcohol some small maggots, the natural habitat of which he wrote was "in the old pools of crude petroleum oil that is

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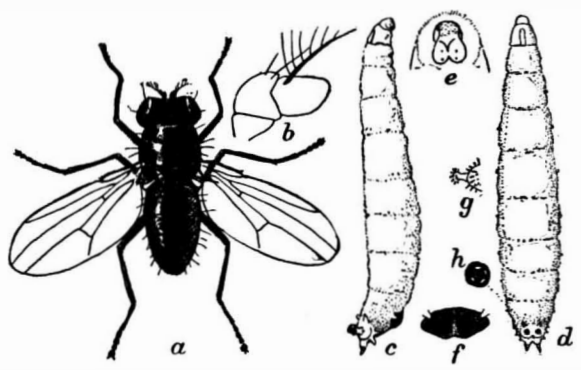
wasted around the oil wells here in the city of Los Angeles." He further stated that there were any quantity of the maggots, and that he could furnish them by the gallon if necessary. The commissioners had been asked many times to name the insect, but could not do so, and wrote in search of information. Suspecting that these larvæ would prove to belong to the family Ephydridæ, the species of which have a habit of breeding in extraordinary substances, we urged Mr. Kellogg to make an attempt to rear the adults, which he succeeded in doing July 9. A shallow dish filled with crude oil containing about fifty of the maggots was placed in a flat box with a glass top on June 18. In nine days the first maggots were seen to emerge from the oil and crawl to the underside of the glass cover of the cage, where they pupated the following day. On July 9 the first adults were seen, having issued during the night, twenty-two days from the time of placing the maggots in the cage. Prior to this attempt, Mr. Kellogg had sent us specimens in crude petroleum, but naturally, owing to the shaking of the bottle on the trip, the maggots died from suffocation. Experiments made before shipment showed that, when the maggots were bottled up in a full bottle for twenty-four hours, they were killed. Although the writer has the most perfect confidence in the testimony of Mr. Kellogg, and of his assistant, Mr. George Compere, gained through personal acquaintance and extended correspondence, he was anxious to verify the observations himself, and therefore suggested other methods of sending the insects to Washington. The solution was reached by the shipment of the maggots in moss perfectly saturated with crude oil. They were sent from Los Angeles August 27 and arrived in Washington in good condition. On September 20 one adult issued.

This specimen, together with those previously reared in Los Angeles, were submitted to Mr. D. W. Coquillett for study, and he has decided that the insect which possesses this abnormal habit is a new species of the Ephydrid genus Psilopa, which he has named Psilopa petrolei.

There is no record in entomological literature of the habits of this genus Psilopa. Records of the habits of other Ephydrid genera are as follows: Ephydra and Halmopota in salt pits in Europe, the former in salt pits in this country and in alkaline lakes in the West; Teichomyza in human urine; Notiphila on the stems of water plants; Hydrellia in the sap of trees; Pelina and Parydra in water—character of water not mentioned. It is obvious from this that the family is practically subaquatic in its larval stage. The larvæ of some forms possess branchiæ, while others breathe by means of protected anal stigmata which they occasionally protrude for air above the surface of the water. This latter method is the one by which the larva of the petroleum maggot secures its air. Obviously the stigmata are very thoroughly protected, and when we consider that only this protected pair is functional there is, after all, nothing so very curious about the habit of the insect, since the insecticidal properties of petroleum depend upon the closing of the air holes or spiracles by the oil. The adult of the Psilopa breathing through normal spiracles is as readily killed by petroleum as any other insect. The question of the food of the larvæ is not a difficult one, since in these petroleum pools



PSILOPA PETROLEI, COQ.

a, adult; *b*, antenna of same; *c*, side view of larva; *d*, dorsal view of same; *e*, ventral view of larval head; *f*, ventral plate on anal segment of larva; *g*, enlarged lateral tubercle of larva; *h*, enlarged anal spiracle of larva. *a*, *c*, *d*, enlarged; *b*, *e*, *f*, *g*, *h*, still more enlarged (original).

many insects are caught, and it is upon their remains that the larvæ probably feed.

It is strange that there is no reference to this particular insect, so far as we know, in entomological literature. The presence of living maggots in crude petroleum pools, however, has been known to others, the oil men having been familiar with it for years. Discussing the matter incidenta ly with Mr. Clifford Richardson, Superintendent of Tests of the Barber Asphalt Paving Company, recently, Mr. Richardson stated that he had himself seen these maggots in California when visiting the West in the interest of his company, and called the writer's attention to the fact that Mr. S. F. Peckham, in his elaborate report on the production, technology, and uses of petroleum and its products, published in volume x. of the Tenth Census Reports, refers to the same occurrence as lending support to the theory that petroleum oils are of animal origin. The statement which we have just made regarding the probable food of the maggots, if true, would indicate that the presence of the maggots in petroleum has no possible bearing upon the question of the origin of this product. Not having made personal observations in the field, however, the writer is not in position to emphasize this point.

The Current Supplement.

The current SUPPLEMENT, No. 1205, is a particularly interesting number, owing to the diversity of the subjects treated in the articles. Probably the most important paper is "Ethics of Primitive Peoples," a lecture by Dr. D. G. Brinton, specially reported. "Mirage" is an interesting lecture by Major P. A. MacMahon, F.R.S. "Brick and Clay in the Bible" is a curious article and "Our Trade with Japan" and "Our Trade with China," and "Scotch Opinion of United States Goods" give timely articles on economic subjects. "Over-Pressure in Schools" is a letter by Dr. R. H. Thurston. On the front page is a view of the French battleship "Jauréguiberry" at full speed.

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RECENTLY PATENTED INVENTIONS.

Agricultural Implements.

POTATO-DIGGER.—ROBERT B. PATTERSON, Ludington, Mich. The potato-digger of this inventor is designed, not only to dig potatoes, but also to sort them and to deliver them to crates The digger has a revoluble assorting-cylinder provided with peripheral pockets adapted to receive potatoes, and with peripheral openings through which small potatoes may pass to the interior of the cylinder. The potatoes, after having passed through the cylinder-openings, are conducted to a receptacle. The digging-fork is readily controlled by the driver by means of a crank-arm and rock shaft, and may be regulated as the character of the soil may demand.

Bicycle-Appliances.

BICYCLE-SUPPORT.—WILLIAM F. WILLIAMS, London, England. This invention provides improved means whereby a bicycle, when traveling very slowly or when stopped, may be maintained in an upright position. The support consists of a bracket having a vertical member fitted to slide up and down and to turn upon a spring-surrounded tubular pillar which projects down from the crank-hanger of the machine. The frame has horizontal arms provided with rollers adapted to rest on the ground in order to afford the lateral support required. By pulling upon a cord, a lever will be caused to bring the arms and rollers to operative position.

BURGLAR-ALARM. — CHARLES T. KUNZ, New York city. The burglar-alarm is arranged so that when an opening door presses down upon the device, a part will be released and caused to explode a cap or cartridge. The alarm comprises a casing, a breech-block, a spring-actuated plunger, and a latch for holding the plunger. The plunger, in operation, is drawn back against the resistance of its spring and held by the latch. A blank cartridge is then placed in the breech-block. When pressure is exerted on the casing, the latch is released and the plunger violently hurled by the spring against the cartridge.

Mechanical Devices.

PUMP-GEAR.—LOUIS H. NICOLAS, Louisville, Ky. The improved, hand-operated ship's pump-gear provided by the present invention has a spring-beam adapted to be connected with the upper end of the pump-rod. A link is connected with the pump-rod, and a crank shaft is connected with the link and is provided with a driving pulley. Over the segmental pulley-rim of a pivoted hand-lever, a rope extends. A pendulum and a fly-wheel are secured on the shaft. The operator, by moving the hand-lever in one direction, starts the pendulum in the opposite direction, and the momentum acquired carries the lever to the end of the stroke.

ALVEOLI-AMPUTATING FORCEPS.—DR. GEORGE B. CLEMENT, Macon, Miss. A novel construction of forceps has been devised by this inventor, for the purpose of amputating or trimming the jagged edges of the alveolar processes after the extraction of teeth. Of the two beaks of the forceps, one has an interior flat face, the other an interior concave face formed with a curved cutting edge, extending around the sides and ends and shutting against the flat face of the other beak. The flat-face beak is tapered to a sharp, wedge-shaped end and is made relatively thinner and of wider contour than the other beak, so as to project beyond the edge.

WRENCH.—FRANK T. VERHAREN, Spencer, Iowa. The movable jaw of the wrench may be quickly adjusted on the toothed shank by means of an internally-toothed adjusting sleeve having a longitudinal groove on its inner side. This groove may be brought into register with the toothed edge of the shank to permit the sliding of the movable jaw to and from the fixed jaw. By turning the sleeve in an opposite direction, the teeth or threads on the jaw will be caused to interlock with those on the shank.

MACHINE FOR PICKING CURLED HAIR.—EDGAR BEERS, Georgetown, Conn. This machine comprises two sets of feed-rollers, one set being mounted rearwardly of the other; a reciprocating comb rearwardly of each set of rollers; and mechanism consisting of a sectional shaft and clutches whereby both sets of feed-rollers may be operated while the other set is at rest. In operation the ropes of hair are fed between the rollers. At each downward stroke of the comb, the teeth will engage the ends of the rope and draw the hairs downward, so as to loosen the rope and to pick the hairs thoroughly.

APPARATUS FOR CONCENTRATING AND AMALGAMATING PRECIOUS METALS. — WILLIAM W. HABERSHAM, Gainesville, Ga. In ordinary sluicing operations the heavier gold-particles are precipitated into sluice-boxes and are either united with the quicksilver in the riffles or raised on the bottom of the boxes, whereas the fine or flour gold is washed away and lost. To obviate this difficulty, this invention provides a construction of sluice boxes and riffles in combination with tubs, vessels, and wheels, the principle of which construction being that embraced in the action of water in streams in which eddies are formed, and in which the sediment carried off by the natural current is stayed and deposited. With the aid of a sodium amalgam, the miner is enabled to save the greater portion of the gold now lost.

CIGAR-CUTTER AND MATCH-SAFE.—ANDREW R. FOSSUM, Cottonwood, Minn. To provide a combined cigar-cutter and match-safe arranged to cut the cigar and to deliver a match to the user, is the purpose of this invention. The combined cigar-cutter and match-safe has a manually-operated lever, which actuates a cutter. A match-picker in the form of a man is mounted to turn, and is arranged to be swung into an inclined position to pick up a match. The movement of the lever serves to turn and to swing the picker.

CAR-LOADING APPARATUS, — PHILIP OBERST, West Superior, Wis. It is the object of this invention to provide an improved apparatus for loading rails and logs upon cars. The apparatus includes three "horses" or movable supports, which are adapted for use either upon the gronnd or upon a flat-car. The horses have each a top section which is hinged and adapted to be thrown back for the purpose of lessening temporarily the height of this support, so that the rails may slide into the car by gravity.

HYDRAULIC PROPELLER FOR SHIPS. — ANDREW PLECHER, Savannah, Ga. This invention is an improved jet propeller, and consists of a rotatable screw or spiral blade propeller arranged in a tube traversing the vessel from stem to stern and taking in water at its front end to discharge it at the other. The improvements are found in the use of cut-off valves arranged on each side of the screw, and other valves for controlling the admission of water from the hold.

PAINTING MACHINE.—M. G. BARRIER, Louisville, Miss. The painting machine is especially designed for painting high smoke-stacks, and consists of a guide-pulley having a support adapted to be hooked over the edge of a stack, and a paint-box and brush attached thereto, suspended from the pulley. An operator below may, by manipulating the rope from which the paint-box is suspended, paint the sides of a tall stack.

Miscellaneous Inventions.

LUBRICATOR. — HEINRICH FROBOESE, Bielefeld, Germany The present lubricator is especially applicable for use on cycle and similar bearings. The device is provided with a double closure for preventing dust from penetrating into the bearings, the inner closure being effected by a plug completely shutting off the lubricator-hole from the bearings, while the second additional closure is formed by a cover.

DUMPING ATTACHMENT FOR WHEELED SCRAPERS.—ANSON TITUS, National City, Cal. In connection with the wheels of the scraper and the scoop, bars are used, mounted to slide at the rear end portion of the scraper and having their ends arranged for clamping engagement with the wheels of the scraper in order to be automatically operated thereby. A lever is connected with both bars, and is arranged simultaneously to move the bars in opposite directions.

TAILPIECE FOR STRINGED MUSICAL INSTRUMENTS.—GEORGE F. WELLS, Philadelphia, Pa. In most tailpieces the string is attached in such a manner that it is bent over a sharp edge; so the string consequently soon breaks. In the present invention a plate is used, upon which a cam-lever or shoe is pivoted. The lever or shoe has a split at the toe adapted to receive the knotted end of a string. The strain upon the string is hence more nearly a direct pull.

GLORY-HOLE. — ANDREW DAUBENMEYER, Nashville, Tenn. To provide improvements in glory-holes for fire-polishing glassware, whereby a large amount of ware can be subjected to a uniform heat, is the purpose of this invention. The furnace used is provided with a heating-chamber having a transverse wall and a semi-circular outer wall. The transverse wall is formed with openings for the entrance and exit of the glassware. The outer wall is formed with a slot for the passage of the arms carrying the rotating supports for the glassware.

SUSPENDERS.—EDWARD DENIS, Green Bay, Wis. The suspenders have shoulder-straps provided at their ends with snap hooks carrying two chains or wires arranged, respectively, at the sides of the wearer. The chains or wires are adapted to be connected with the trousers.

GAME-APPARATUS.—CHARLES EDWARDS, Brooklyn, New York city. This apparatus comprises two revoluble wheels, a belt or cable passing over the wheels, and horizontally extending yielding arms secured to the cable, each carrying a ball. The device is used by stationing a striker with a bat alongside one of the runs of the cable, so that the ball is traveling toward him. As the ball approaches, he endeavors to hit it with a bat. By the curving of the ball's path, this is sometimes very difficult. It may be made more difficult by causing the ball to travel in an undulating path.

RUNNING-GEAR FOR VEHICLES.—LAFAYETTE L. NICHOLS, Inverness, Fla. The present invention provides a durable connection between the reach of a vehicle and the forward axle and bolster without the aid of a king bolt, the connection being so effected that all the advantages of a fifth-wheel will be obtained and the running-gear will be rendered stronger than in the usual construction. A coupling is also provided which permits the use of a long or short reach.

PROTECTIVE HEAD-SCREEN.—HENRY E. BEACH, Grand Forks, Canada. To provide a combined cap and screen which can be worn without discomfort and which will serve as an effectual protection against mosquitoes and other insects is the purpose of this invention. The head-screen consists essentially of a globular screen inclosing a cap and adapted to surround the head of the wearer.

DUMPING-VEHICLE.—THOMAS HILL, Jersey City, N. J. In most dumping-vehicles, the body works from one especial bearing to another and rests on both at the same time until a second action in tilting is made in order to dump the load. In the present invention, there is no sliding motion and the dumping action is continuous. This is due to the fact that the vehicle-body of the present invention has its trunnions working in guides extended at an upward angle to metal boxes.

NON-REFILLABLE BOTTLE.—PHILIP J. FRIEDRICH, Coytesville, N. J. The neck of the bottle has a tube in which are arranged two spiders, between which a valve-stem and valve are adapted to move and to be held normally in position by means of a ball and spring. The bottle can be readily emptied, but cannot be filled owing to the position of the ball on the valve-stem and the seating of the valve.

CARBURETER.—ROBERT D. BRADLEY, Linchester, Md. This improved gas-apparatus comprises a vertical casing in which a frame is arranged. On the frame an oil-pump and a vertically-movable gas-receiver are arranged. In the frame a rotatable air-carbureting apparatus is mounted and connected by mechanism with the gas-receiver for automatically and intermittently rotating the carbureter. The peculiar merit of the invention lies in the automatically-controlled generation of a measurably-fixed aero carbon gas.

Designs.

SAD-IRON HOLDER. — GEORGE W. CLEWELL, Reading, Pa. The sad-iron holder of this inventor is intended to be sunk into the ironing-board so that its supporting surface shall be flush with the board. Hence, when one has finished ironing, the sad-iron is not lifted from the board, but is merely pushed into the holder.

GAS-METER-DIAPHRAGM HOOP.—JOHN HEARNE, Brooklyn, New York city. This hoop at the gas-inlet is provided with a shield in order to prevent the leather's being burnt during the process of soldering the hoop to the diaphragm.

HAND-WHEEL.—JOHN ORMEROD, Brooklyn, New York city. The leading feature of the design consists in providing the wheel with a continuous chain of closely grouped spheres. The wheel is designed for use on sodawater fountains, and fits the form of the hand better than the ordinary wheels.

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(7581) E. R. N. says: 1. Will you kindly publish in your paper how compressed yeast is made? A. Indian corn, barley, and rye (all sprouting) are powdered and mixed, and then macerated in water at a temperature of from 149° to 167° F. Saccharification takes takes place in a few hours, when the liquor is racked off and allowed to clear, and fermentation is set up by the help of a minute quantity of any ordinary yeast. Carbonic acid is disengaged during the process with so much rapidity that the globules of yeast are thrown up by the gas, and remain floating on the surface, where they form a thick scum. The latter is carefully removed and constitutes the best and purest yeast, which, when drained and compressed in a hydraulic press, can be kept from eight to fifteen days, according to the season. 2. A formula for making a leather cement. A. This is made by mixing 10 parts of bisulphide of carbon with 1 part of oil of turpentine, and then adding enough gutta percha, cut into small pieces, to make a tough, thickly-flowing liquid. One essential prerequisite to a thorough union of the parts consists in freedom of the surfaces to be joined from grease. This may be insured by laying a cloth upon the part to be joined and applying a hot iron for a time. The cement is then applied to both pieces, the surfaces brought in contact, and pressure applied till the joint is dry.

(7582) R. J. W. asks whether Mason's principle of hygrometry is the correct one. A. Mason's hygrometer is a wet and dry bulb thermometer whose readings taken together give the relative humidity of the air. There is no better method known for finding it. See Davis' "Meteorology," price $3, Ganot's "Physics," price $5, for reliable data on this point.

(7583) E. W. M., China, asks: 1. In an electric motor is the chief attraction or pull of the field magnets exerted on the currents circulating in the wires on the armature or on the magnetism excited in its core? A. The current around the field of a motor produces a large number of lines of force across the space in which the armature is to turn. The current through the armature coils of a motor is so directed that the lines of force which it produces, in their effort to place themselves parallel with the lines of force of the field, twist the armature around. The commutator, if the motor uses the direct current, acts so as to shift the current from coil to coil and maintain the twist, or torque, as it is called, indefinitely. The iron core of the armature is used because lines of force pass through iron more easily than through air or any other substance. 2. If the chief attraction is on the magnetism in the core, would it not be an advantage to make the core with projecting lugs, the windings being between and wound up even with the lugs? A. Armatures are often made with slots in which to wind the coils. 3. Is it practicable in the construction of a motor to take advantage of the repulsion as well as the attraction between the field and the armature? A. There is attraction on one side of a coil for one pole and repulsion from the opposite pole on the opposite side. 4. How shall I wind a four-pole armature to run as a motor in a two-pole field? A. Wind so that the poles shall be alternately plus and minus as you go in either direction around the armature. Make a four-post commutator, and join ends of the coils to its bars.

(7584) R. H. B. asks: Has any other mixture besides silver and nickel been found for use in the Marconi coherer in wireless telegraphy? I have been using in my coherers (home-made) a mixture of silver filings and carbon together with a small quantity of iron filings. I dispense with resistance and choke coils and use a simple good telegraph relay. The coherer thus made is extremely sensitive, the signals clear cut and decisive. The percentage of carbon is from about 45 to 50 per cent. About ¼ per cent of iron filings is sufficient. With this mixture there is no need of any contrivance to regulate the pressure on the powder. With the same coherer I have telegraphed at short distances and through brick walls at long distances. I mention these things simply for the help it may give to others experimenting in this line, if, perchance, no better mixture has been found. A. We are unable to say what mixtures have been tried.

(7585) N. S. J. writes: A correspondent in your issue of December 17 recalls to my mind experiments often made when I was a mere lad by rubbing lumps of white sugar together in the dark. Let me add, in further vindication of this writer's theory, that the luminosity is mechanical rather than electric; that I have often noticed with interest a similar phenomenon when two pieces of hard stone are rubbed together. That it is not phosphorescence seems to be proved by the fact that the light is in some cases quite red. I would suggest that two disks of amorphous quartz arranged for mechanical friction would afford fine opportunity for experiment because the light is very abundant; but even granite will produce it. The loss by friction in any case is trifling.

(7586) J. R. asks: 1. Why do I not get any current from my shunt machine on short circuit? A. A shunt machine will give no current on short circuit, because all of the voltage is lost in the armature circuit and none in the outside circuit. 2. Is there any way to connect a single dynamo to a three-wire circuit? A. You can connect the middle wire of the three-wire system with one terminal of a dynamo and the two outside wires with the other. You, however, lose the advantage of a three wire-circuit, as this makes it a double two-wire. Another way would be to wind the armature with two circuits, one for one side and one for the other. By this means, however, the branches would have to be balanced, or the regulation would be very poor.

CORRECTION.—In answer to query 7545, volts per candle should read "watts per candle." Electric lamps are rated in watts. One watt is the power of one ampere of current at a pressnre of one volt. To calculate the watts, multiply the volts by the amperes.

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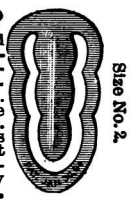
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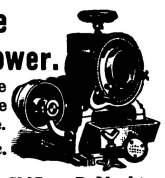

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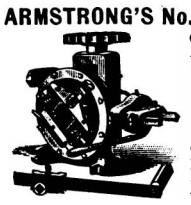

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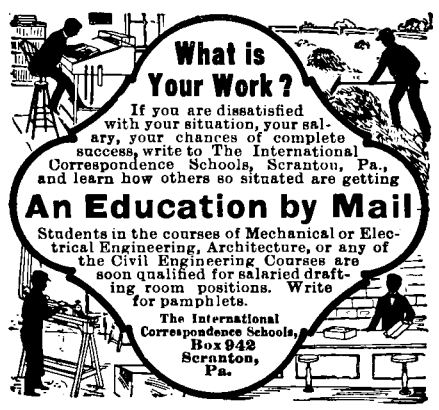

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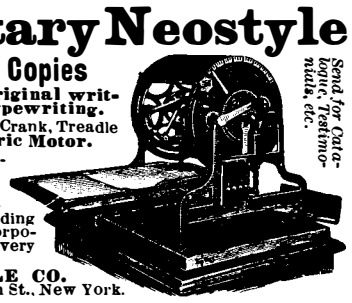

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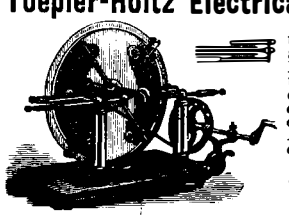

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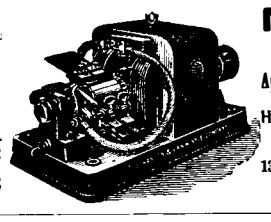

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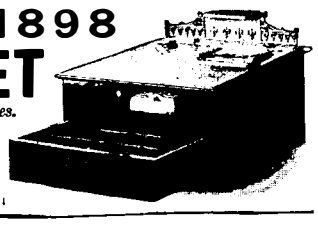

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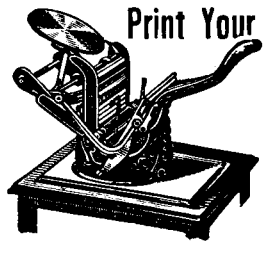

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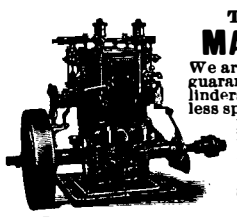

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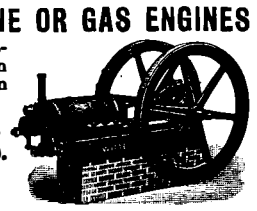

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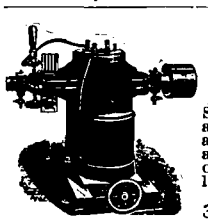

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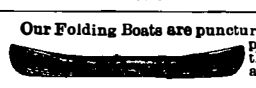

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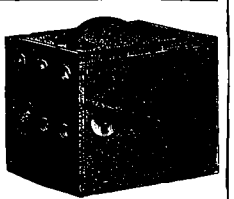

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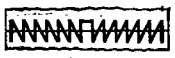

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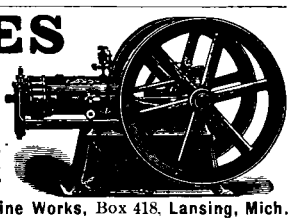

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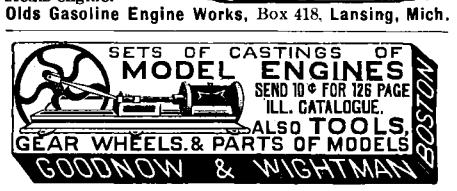

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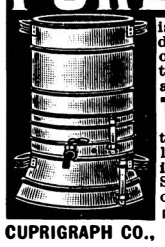

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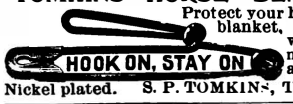

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Weighing machine, automatic, F. H. Richards	618,384
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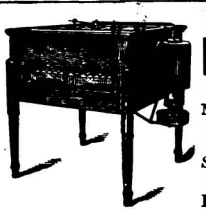

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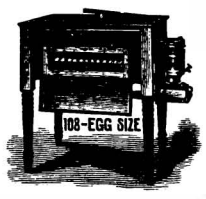

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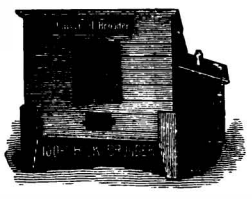

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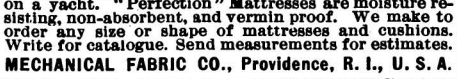

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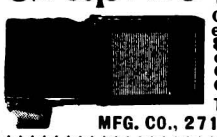

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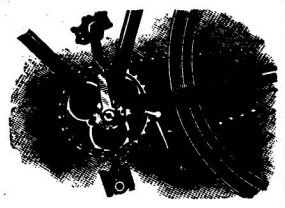

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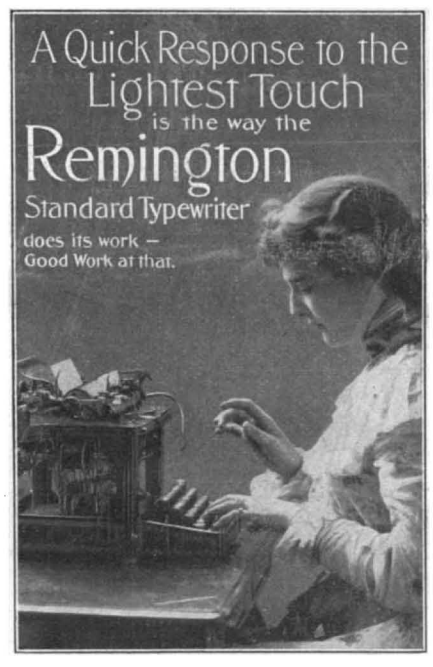

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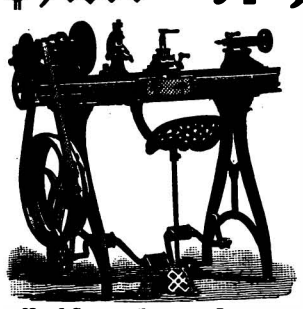

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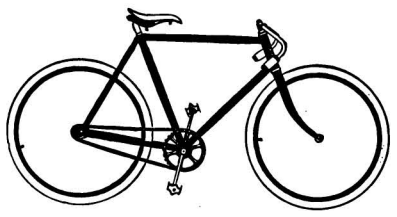

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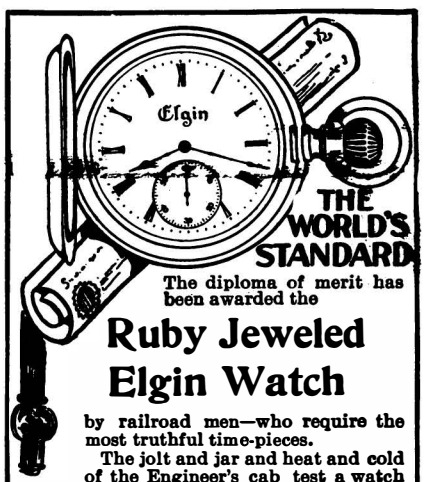

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